Cooling Water Intake Study
316 (b) Demonstration

J. H. MILLER

STEAM ELECTRIC GENERATING PLANT

Unit No. 1

Alabama Power

J. H. MILLER STEAM ELECTRIC GENERATING PLANT
316(b) Demonstration

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Summary and Conclusions

Summary

This document, along with accompanying appendices containing summarized data, comprise Alabama Power Company's 316(b) demonstration for the J. H. Miller Steam Plant, Unit No. 1. It summarizes results from engineering and biological field studies to evaluate the effects of the intake system, associated with Unit No. 1 operation, on the aquatic organisms of the Black Warrior River (Mulberry Fork). This report has been prepared by engineers and biologists of Alabama Power Company and by members of the Fisheries Staff of Auburn University. Drs. John Lawrence and David Bayne of the Department of Fisheries and Allied Aquacultures, Auburn University, were responsible for plankton studies.

Conclusions

1. Study results indicate that the effects of intake operation on impingeable organisms are insignificant relative to the J. H. Miller Unit No. 1 operation.
2. No rare or endangered species of fish or shellfish were collected during impingement monitoring, nor are there any rare or endangered species expected to be affected by plant operation.
3. Variations in phytoplankton and zooplankton densities occurred over the course of the study; however, there were no qualitative or quantitative changes in plankton communities of the adjacent Black Warrior River (Mulberry Fork) attributable to entrainment effects of Unit No. 1 operation at the J. H. Miller Steam Plant.

4. Larval fish populations in the vicinity of the J. H. Miller intake were not found to be significantly affected by entrainment.
5. Macroinvertebrate studies conducted in the vicinity of the J. H. Miller intake failed to indicate the presence of any deleterious effects which could be associated with entrainment of these organisms.
6. It is concluded that operation of the intake system associated with Unit No. 1 of the J. H. Miller Steam Plant is not significantly affecting populations of aquatic organisms.

The Miller Steam Electric Generating Plant is located near West Jefferson in Jefferson County, Alabama (see Figure II-1). The plant intake is located on the Mulberry Fork of the Warrior River near River Mile 406.8, as shown in Figure II-2.

The Warrior River at River Mile 406.8 is approximately 300 feet wide and has a drainage area of approximately 1970 square miles.

The United States Geological Survey has operated a gaging station on the Black Warrior River at Northport, Alabama .35 miles upstream from Oliver Lock & Dam, River Mile 338.50, which covers an intermittent period of record from 1889 to the current year. This gage has a drainage area of 4828 square miles. The long-term daily average flow past the Miller Plant intake is determined from the flow at Northport by ratio of the drainage area at Northport to the drainage area at the Miller Plant. The long-term average daily discharge of the Warrior River at the Miller Intake (river mile 406.8) is 3215 cfs. This flow is based on 58 years of record as published in the 1978 Water Year U.S.G.S. Surface Water Records.

The maximum Miller Plant water requirement, with four units operating, will be 30,000 GPM or 66.84 cfs. The Miller Plant withdrew at an average rate of 11,000 GPM (24.5 cfs) during initial one-unit operation between May 1979 and November 20, 1979 until the ash sluice water recycling system became operational on November 21, 1979, at which time the normal water consumption dropped to approximately 1500 GPM (3.3 cfs) and the intake system operation became cyclical with the intake pumps operating on the average of 1.19 hr/day.

The studies in this report are limited to the stretch of the Warrior River near the Miller Steam Plant (see Figure II-3).

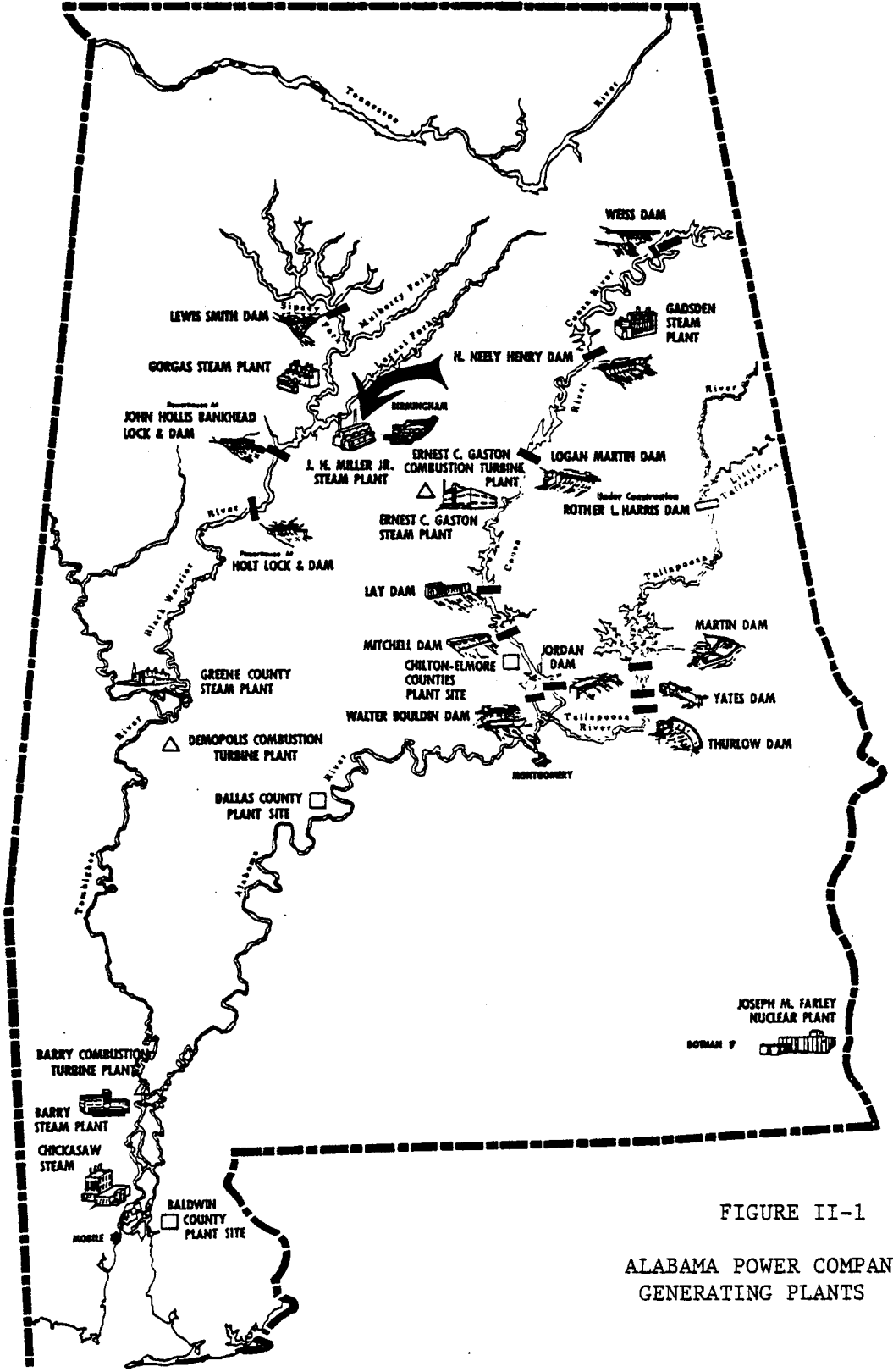
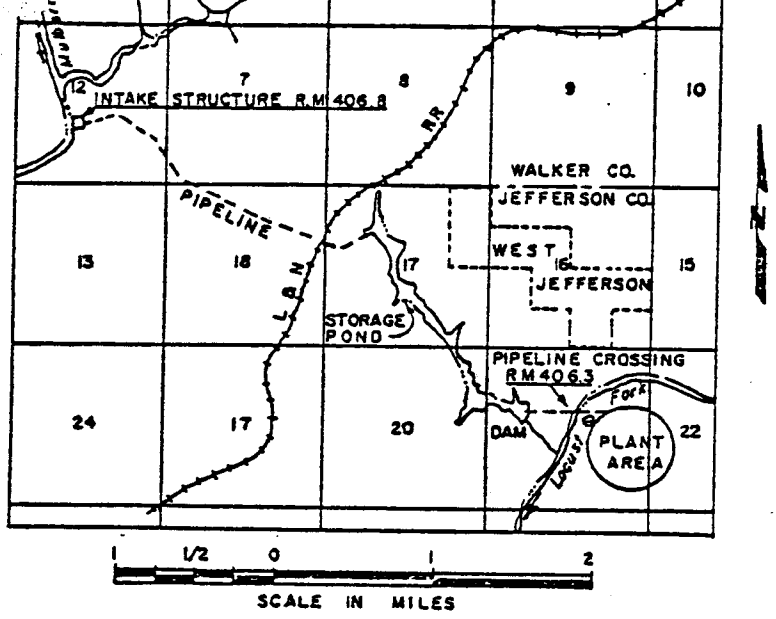
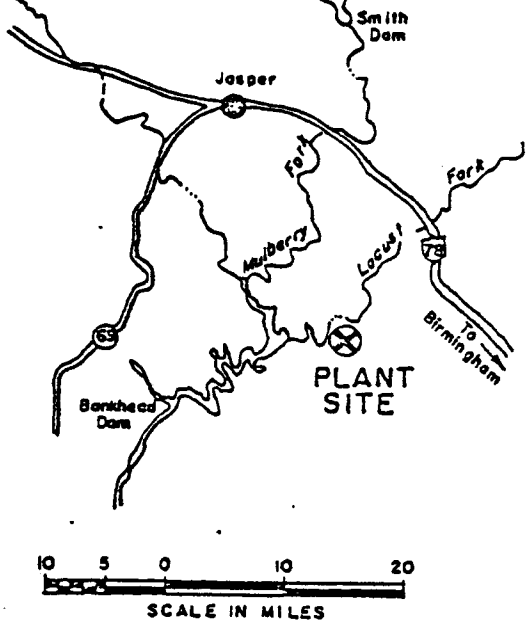


FIGURE II-1

ALABAMA POWER COMPANY
GENERATING PLANTS



LOCATION MAP
TAKEN FROM U.S.G.S. MAP



VICINITY MAP
TAKEN FROM GENERAL HWY MAP

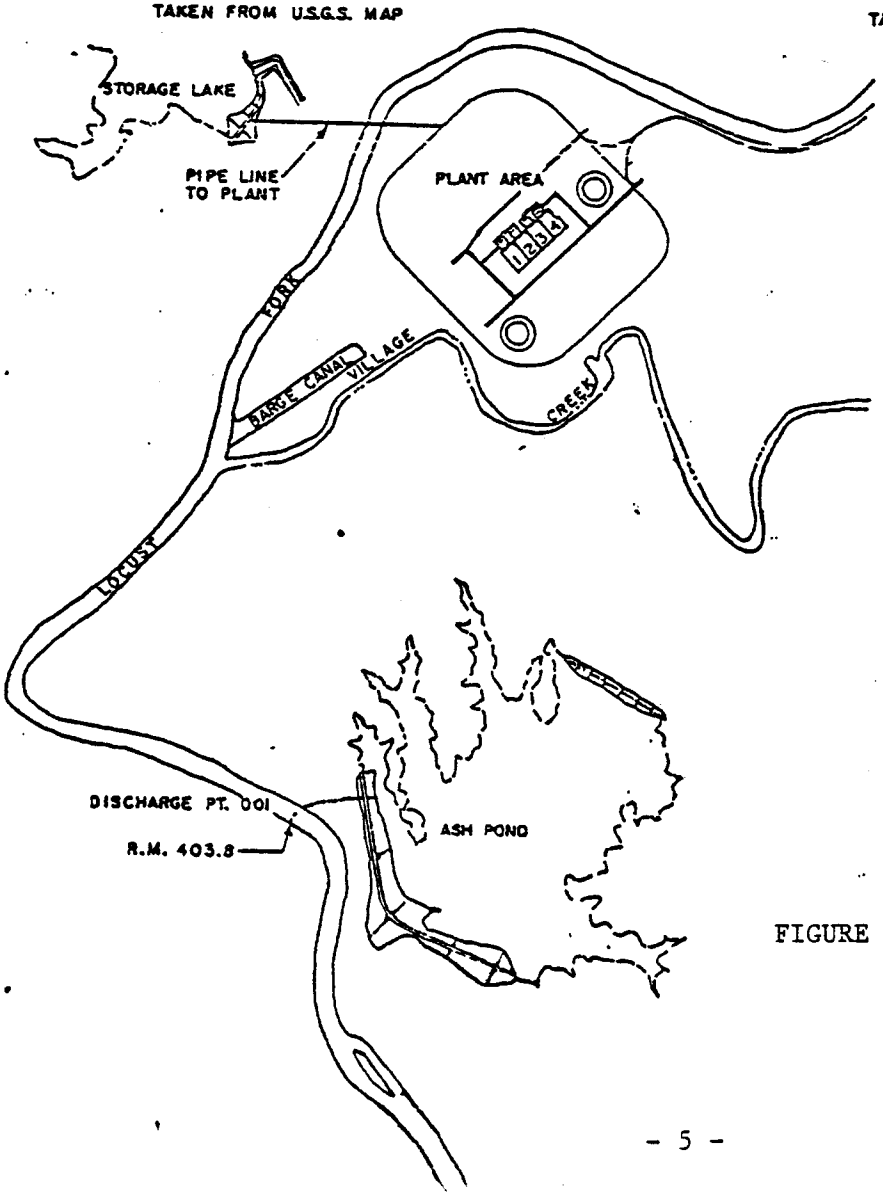


FIGURE II-2 MILLER STEAM ELECTRIC GENERATING PLANT LOCATION

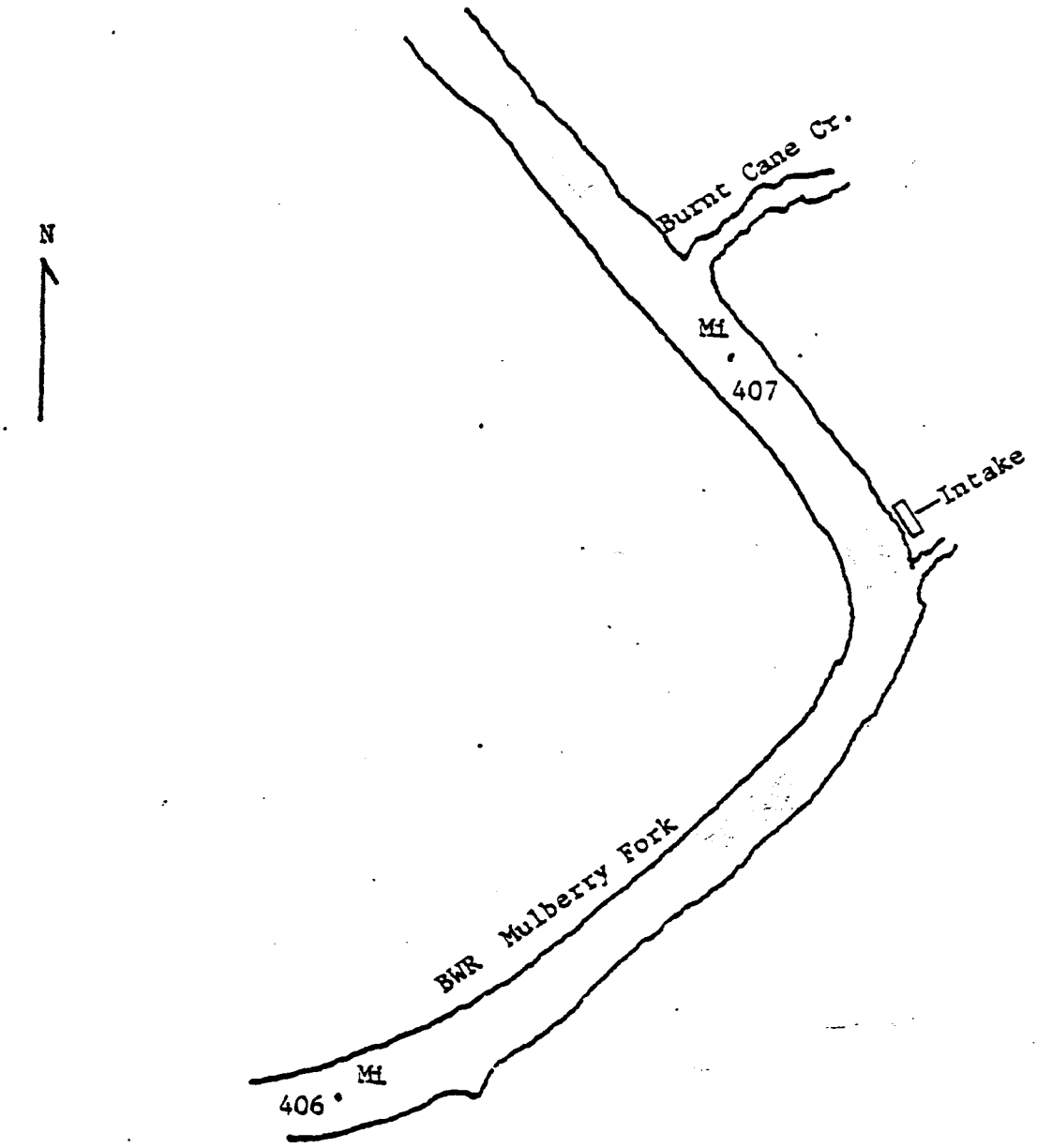


FIGURE II-3. Location of Miller Intake Structure on the Mulberry Fork of the Black Warrior River.

The Miller Steam Electric Generating Plant will have four (4) independent generating units operating on cooling towers with a combined manufacturer's rated capacity of 2640 MW. Individual unit capacities and projected in-service dates are shown in Table II-1.

TABLE II-1 MILLER STEAM PLANT UNIT CAPACITY

Unit No.	In-Service Date	Manufacturer's Rated Capacity (KW)
1	October 12, 1978	660,000
2	~~June 1983~~	660,000
3	March 1985	660,000 ?
4	March 1987	660,000 ?

Table II-2 presents the average monthly operating parameters for Miller Steam Electric Generating Plant from October 1978 through February 6, 1980.

Intake Description

As illustrated on the map, Figure II-2, the plant intake is located on Mulberry Fork of the Warrior River. The intake structure drawings are contained in Appendix A, sheets 1-5. The intake structure includes a skimming weir which withdraws intake water during normal flow conditions between nine feet and 28.5 feet below the water surface. The design of the trash racks at the intake provides for 5/16" bars spaced on 1-9/16" centers, resulting in a clearance of only 1¼". This very close spacing of the trash bars improves the effectiveness of the hydraulic sweeping action and is coupled with a design flow velocity through the trash rack of .32 ft/sec. This low velocity is about equal to the average river velocity at the intake location. The resulting velocity ratio (river velocity to intake velocity) of about 1:1 further enhances the probability that fish will not be attracted to the intake structure.

There are no chemicals used in the intake system.

AVERAGE DAILY FLOW RATES FOR MILLER STEAM PLANT
AND THE MULBERRY FORK OF THE BLACK WARRIOR RIVER

Month	Miller Cooling Water (average daily flow cfs)	Mulberry Fork at Miller Intake (average daily flow, cfs)
October 1978	12.3	539
November	23.1	275
December	19.8	853
January 1979	20.6	6621
February	19.2	5225
March	20.6	10928
April	11.1	17073
May	19.7	2600
June	28.4	2052
July	24.2	2249
August	27.6	1844
September	23.5	2662
October	24.1	1653
November	24.1*/5.2**	N/A
December	4.7	N/A
January 1980	.8	N/A
February	5.9***	N/A

FOOTNOTES: * - Period from November 1 through November 20, 1979
** - Period from November 21 through November 30, 1979
*** - Period from February 1 through February 6, 1980

Impingement

Monitoring Procedures

Impingement monitoring at the J. H. Miller Steam Electric Generating Plant began on ~~August 31, 1979~~ and extended through ~~February 4, 1980~~. Impingement monitoring at the J. H. Miller Plant was not conducted in the conventional manner since the intake at the plant does not have traveling screens. The effects of impingement were determined by placing a net in the effluent from the river water intake pumps, at a point where the pumps discharge into an open transfer pond.

Sample procedures to evaluate impingement effects consisted of placing a conical net seven feet in length, with a mouth diameter of two feet, in front of the river water pump discharge pipe. The ¼ inch mesh net was positioned immediately in front of the four foot diameter discharge pipe by inserting the net frame in a metal channel attached to the discharge structure. Sampling was accomplished by inserting the collection net in the holding frame at the pump discharge structure for the duration of pump operation occurring during each two-week sample period.

Fish and other aquatic organisms collected during each sampler period were identified, counted, and weighed. Data collected during each sample period represented one'fourth of the total organisms entrained by the river water pumps since the opening in the collection net was one-fourth the area of the pipe opening.

Results and Discussion

Data were collected during twelve sample periods, from ~~August 31, 1978 through February 4, 1980,~~ to evaluate impingement effects associated with the operation of river water pumps at the J. H. Miller Steam Electric

Generating Plant. Impingement data collected during the study are presented in Table III-1, which includes the number and weight of each species collected during each of the twelve sample periods. Impingement monitoring at the J. H. Miller Plant resulted in the collection of 115 aquatic organisms (see Table III-1).

Fish collected during the study were divided into three general categories, which included game species, commerical species, and other species. Table III-2 is a breakdown of the fish species collected during the study and includes the number and weight of each species collected, as well as estimated daily and study period impingement rates for species identified. Game species collected during the study were restricted to the genus Lepomis, and included only the bluegill (Lepomis macrochirus). A total of only six bluegill were collected during the study resulting in an estimated impingement rate for this species of 256 for the monitoring period. The daily estimated impingement rate for bluegill was computed to be 1.63. Game species accounted for 5.36% by number and 7.06% by weight of all fish species collected during the study.

The group of fish designated as commercial species accounted for the majority of the fish collected during the study. Commercial species (as designated by the Alabama Department of Conservation & Natural Resources) collected during the study were restricted to the catfish (Ictaluridae). Catfish collected during the study included the blue catfish (Ictalurus furcatus), channel catfish (Ictalurus punctatus), black bullhead (Ictalurus melas) and the yellow bullhead (Ictalurus natalis). The number of each species of catfish collected during the study, as well as the percent of the total fish represented by each species is presented in Table III-2. The total number of catfish collected during the study represented 70.54% of all fish collected, and 88.53% of the total weight of fish collected. The impingement rate for commercial species (catfish) during the August 31, 1979 through February 4, 1980 study

Impingement Record by Sample Date
for Sampling Period
August 31, 1979 - February 4, 1980

SPECIES	8-31	9-14	9-27	10-11	10-29	11-14	11-30	12-12	12-27	1-7	1-20	2-4	TOTAL
BLUEGILL	0 *	0	0	0	0	0	2	1	0	0	0	3	6
	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.04	0.00	0.00	0.00	0.11	0.24
TOTALS GAME SPECIES	0	0	0	0	0	0	2	1	0	0	0	3	6
	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.04	0.00	0.00	0.00	0.11	0.24
BLUE CATFISH	6	0	0	4	1	1	17	0	0	0	0	0	29
	0.14	0.00	0.00	0.11	0.04	0.01	0.50	0.00	0.00	0.00	0.00	0.00	0.80
CHANNEL CATFISH	0	0	0	0	0	0	0	1	0	0	0	0	1
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
BLACK BULLHEAD	0	0	0	0	0	0	0	0	6	8	0	28	42
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.24	0.00	1.23	1.61
YELLOW BULLHEAD	0	0	0	0	0	0	0	0	0	1	0	6	7
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.52	0.59
TOTALS COMMERCIAL SPECIES	6	0	0	4	1	1	17	1	6	9	0	34	79
	0.14	0.00	0.00	0.11	0.04	0.01	0.50	0.01	0.14	0.27	0.00	1.75	3.01
GIZZARD SHAD	10	0	0	2	0	0	0	0	0	0	0	0	12
	0.08	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
THREADFIN SHAD	12	0	0	2	1	0	0	0	0	0	0	0	15
	0.03	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
TOTALS OTHER SPECIES	22	0	0	4	1	0	0	0	0	0	0	0	27
	0.11	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15
FRESHWATER SHRIMP	0	0	0	0	1	0	0	0	0	0	0	0	1
	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
CRAYFISH	2	0	0	0	0	0	0	0	0	0	0	0	2
	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
TOTALS MISC. AQUATIC SPECIES	2	0	0	0	1	0	0	0	0	0	0	0	3
	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
TOTALS ALL SPECIES	30	0	0	8	3	1	19	2	6	9	0	37	115
	0.26	0.00	0.00	0.14	0.06	0.01	0.59	0.05	0.14	0.27	0.00	1.90	3.42

* Upper and lower values in each column represent total numbers and weight (lbs.), respectively, of organisms collected.

TABLE III-2

Summary of Impingement Data for J. H. Miller Steam Plant
Including Total Numbers and Weights for Fish Species Collected,
Percent by Number, Percent by Weight and
Estimated Daily and Sample Period Impingement Rates
August 31, 1979 - February 4, 1980

COMMON NAME	SCIENTIFIC NAME	IMPINGEMENT SAMPLE DATA TOTAL NUMBER	TOTAL WEIGHT POUNDS	WEIGHT GRAMS	% BY NUMBER	% BY WEIGHT	ESTIMATED IMPINGEMENT RAT BY NUMBER DAILY	BY NUMBER PERIOD	BY WEIGHT (L DAILY	PER
BLUEGILL	LEPOMIS MACROCHIRUS	6	0.24	109.	5.36	7.06	1.63	256.	0.07	10
TOTALS GAME SPECIES		6	0.24	109.	5.36	7.06	1.63	256.	0.07	10
BLUE CATFISH	ICTALURUS FURCATUS	29	0.80	363.	25.89	23.53	9.61	1508.	0.27	42
CHANNEL CATFISH	ICTALURUS PUNCTATUS	1	0.01	5.	0.89	0.29	0.34	54.	0.00	0
BLACK BULLHEAD	ICTALURUS MELAS	42	1.61	730.	37.50	47.35	9.78	1536.	0.35	55
YELLOW BULLHEAD	ICTALURUS NATALIS	7	0.59	268.	6.25	17.35	1.45	228.	0.13	18
TOTALS COMMERCIAL SPECIES		79	3.01	1365.	70.54	88.53	21.18	3326.	0.74	116
GIZZARD SHAD	DOROSOMA CEPEDIANUM	12	0.10	45.	10.71	2.94	2.60	408.	0.02	3
THREADFIN SHAD	DOROSOMA PETENENSE	15	0.05	23.	13.39	1.47	3.39	532.	0.01	2
TOTALS OTHER SPECIES		27	0.15	68.	24.11	4.41	5.99	940.	0.04	5
TOTALS ALL SPECIES		112	3.40	1542.	100.00	100.00	28.80	4522.	0.85	132

period was estimated to be 3,326 fish with a total weight of 116.8 pounds. The average daily impingement rate for commercial species was estimated to be 21.18 for the period of study.

The gizzard and threadfin shad were the only fish species, other than sport or commercial species, which were collected during the study. The impingement rates for gizzard (Dorosoma cepedianum) and threadfin shad (Dorosoma petenense) were estimated to be 408 and 532, respectively, for the study period. These two species of shad represented 24.11% of all fish collected during the study. A summary of the estimated daily impingement rate for all fish species is presented by sample period in Figure III-1.

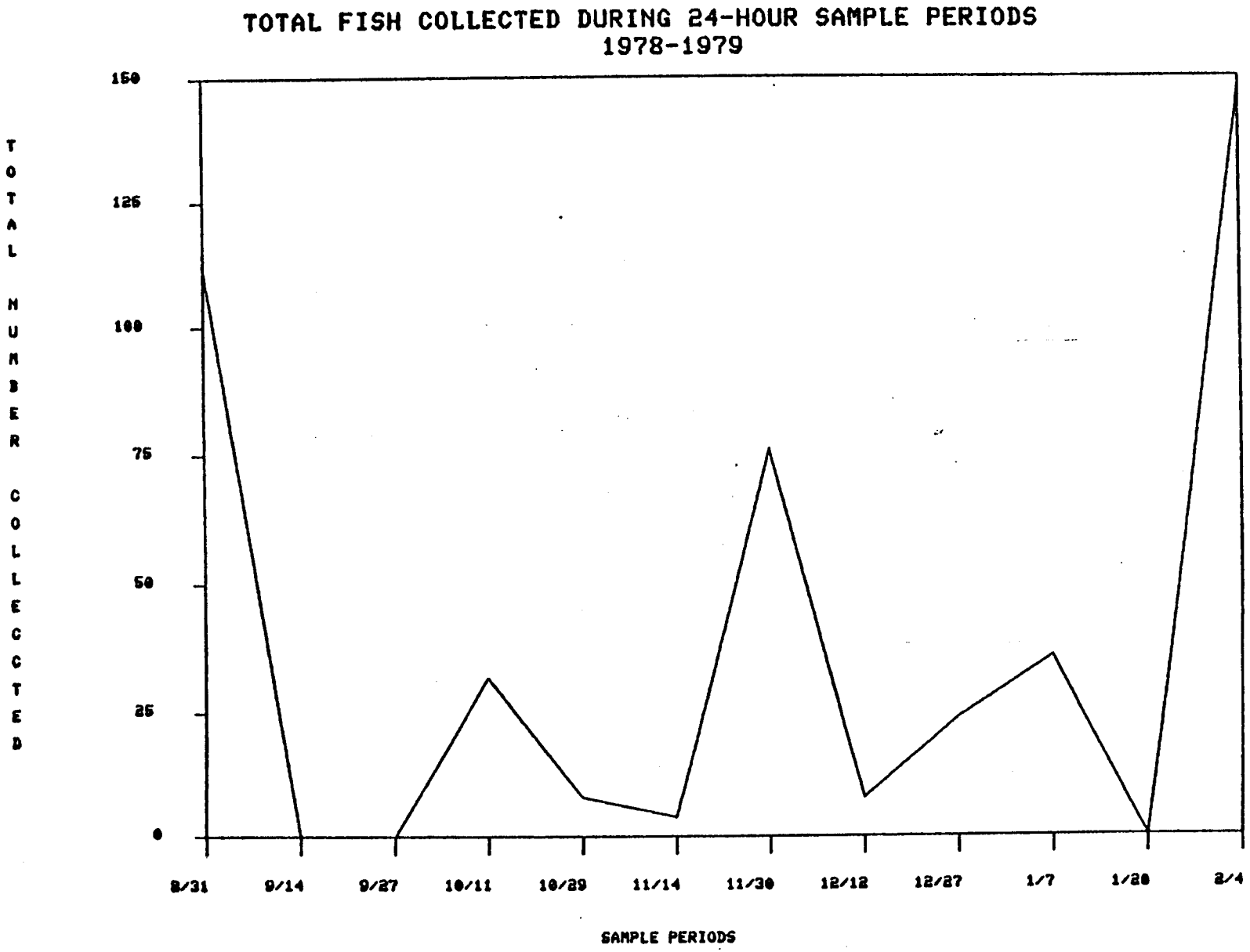
Aquatic organisms other than fish, which were collected during the the study, included the freshwater shrimp and crayfish. A total of one freshwater shrimp and two crayfish were collected during the five month study.

Conclusions

The withdrawal of water from the Mulberry Fork of the Black Warrior River, associated with operation of Unit 1 of the J. H. Miller Steam Electric Generating Plant, was determined not to be significantly affecting populations of inpingeable organisms during the period of study. Data collected during the study indicated low impingement rates for the organisms collected, as well as minimal weights or biomass of organisms removed from the river.

Impingement data collected during the study does not allow the estimation of annual impingement rates for Unit 1 operation, since experience at other Alabama Power Company facilities indicates seasonal variations in impingement rates can be large. Annual impingement rates for one unit operation are (even in the absence of complete seasonal data)expected to be insignificant, based on rates observed during the five-month study period.

FIGURE III-1


TOTAL FISH COLLECTED DURING 24-HOUR SAMPLE PERIODS
1978-1979
TOTAL NUMBER COLLECTED
150
125
100
75
50
25
0
8/31
9/14
9/27
10/11
10/29
11/14
11/30
12/12
12/27
1/7
1/20
2/4
SAMPLE PERIODS

Complete seasonal data on impingement effects of intake operation at the J. H. Miller Plant will be obtained for each of the three additional units (Units 2 through 4), as specified in the NPDES Permit.

Plankton Population Studies

Phytoplankton and zooplankton samples were collected from three sample areas on the Mulberry Fork of the Black Warrior River near the intake structure for Miller Steam Plant. The locations and depths for plankton samples are listed below and shown in Figure III-2.

Location			Depths sampled, m
Sta. 1	Upstream of intake area	WR mi. 407.3	0,1,2,4 and 8
Sta. 2	Intake screen	WR mi. 406.75	0,1,2,4 and 8
Sta. 3	Below intake area	WR mi. 406.5	0,1,2,3 and 8

Dates on which samples were collected were as follows:

Location	Dates
Station 1	8/11/77; 10/11/77; 3/13/78; 5/16/78; 8/3/78; 11/14/78; 2/28/78; 5/17/79; 8/16/79; 10/24/79
Station 2	8/11/77; 10/11/77; 3/13/78; 5/16/78; 8/3/78; 11/14/78; 2/28/79; 5/17/79; 8/16/79; 10/24/79
Station 3	8/11/77; 10/11/77; 3/13/78; 5/16/78; 8/3/78; 11/14/78; 2/28/79; 5/17/79; 8/16/79; 10/24/79

Plankton samples were collected at noon on each date sampled. A submersible pump and hose apparatus was used to collect water at the various depths sampled. Forty liters of river water were passed through a standard Wisconsin style (80 μ mesh) plankton net and all zooplankters were washed from the net bucket into a 100 ml Nalgene container and preserved with 5% formalin. For phytoplankton analysis, a 500 ml water

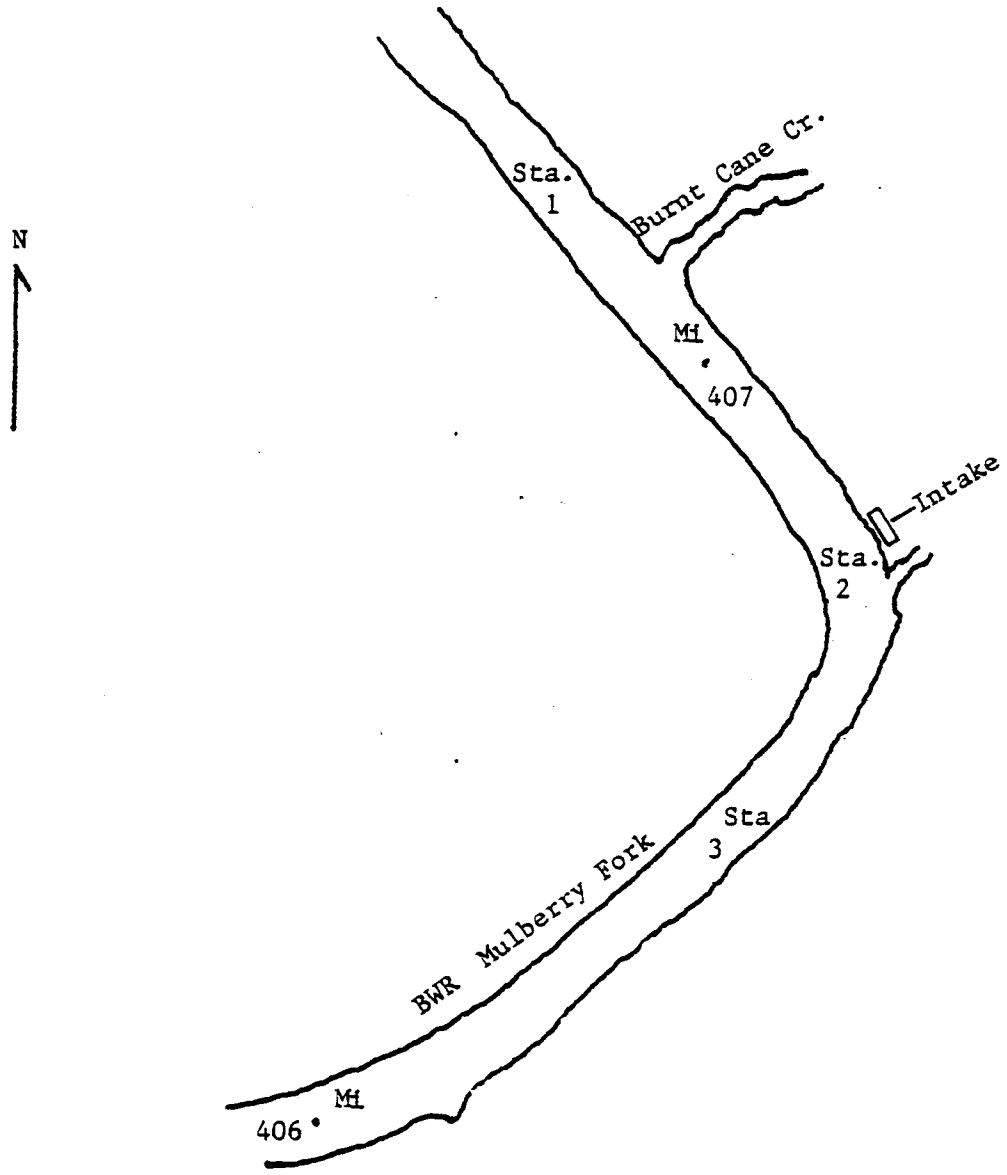


Figure III-2. Locations of plankton sampling stations on BWR Mulberry Fork in vicinity of intake structure for Miller Steam Plant.

sample was taken at each depth and transferred to a 1-liter flat-bottomed Nalgene container spiked with 18 ml of a Merthiolate preserving solution. Samples were transported to laboratory facilities located at Auburn University, Auburn, Alabama and analyzed as outlined below.

Medium	Parameter	Method
Plankton	Phytoplankton enumeration	Counting chamber
	Zooplankton enumeration	Counting chamber
	Chlorophyll determination	Trichromatic

Phytoplankton

Variations in phytoplankton numbers and chlorophyll a concentrations were pronounced as indicated in Figure III-3. Winter phytoplankton communities were dominated by pennate diatoms (Table III-3). Dominance on sampling dates during other seasons of the year was shared by pennate diatoms and various green algal species. Blue-green phytoplankters were more abundant in summer and fall samples but were never dominant. Mean phytoplankton densities ranged from a low of 181.0 organisms/ml 28 February 1979 to a high of 461 organisms/ml 13 March 1978. Mean chlorophyll a concentrations ranged from a low of 1.3 mg/m^3 16 May 1978 to a high of 10.0 mg/m^3 24 October 1979.

Vertical distribution of phytoplankters in the water column, temperature profiles and mean chlorophyll a, b and c concentrations at each sampling site are illustrated in Figures III-4 through III-13. The distribution and standing crop of phytoplankters at the three sampling stations on any date appear similar. Plankton algae were abundant at the

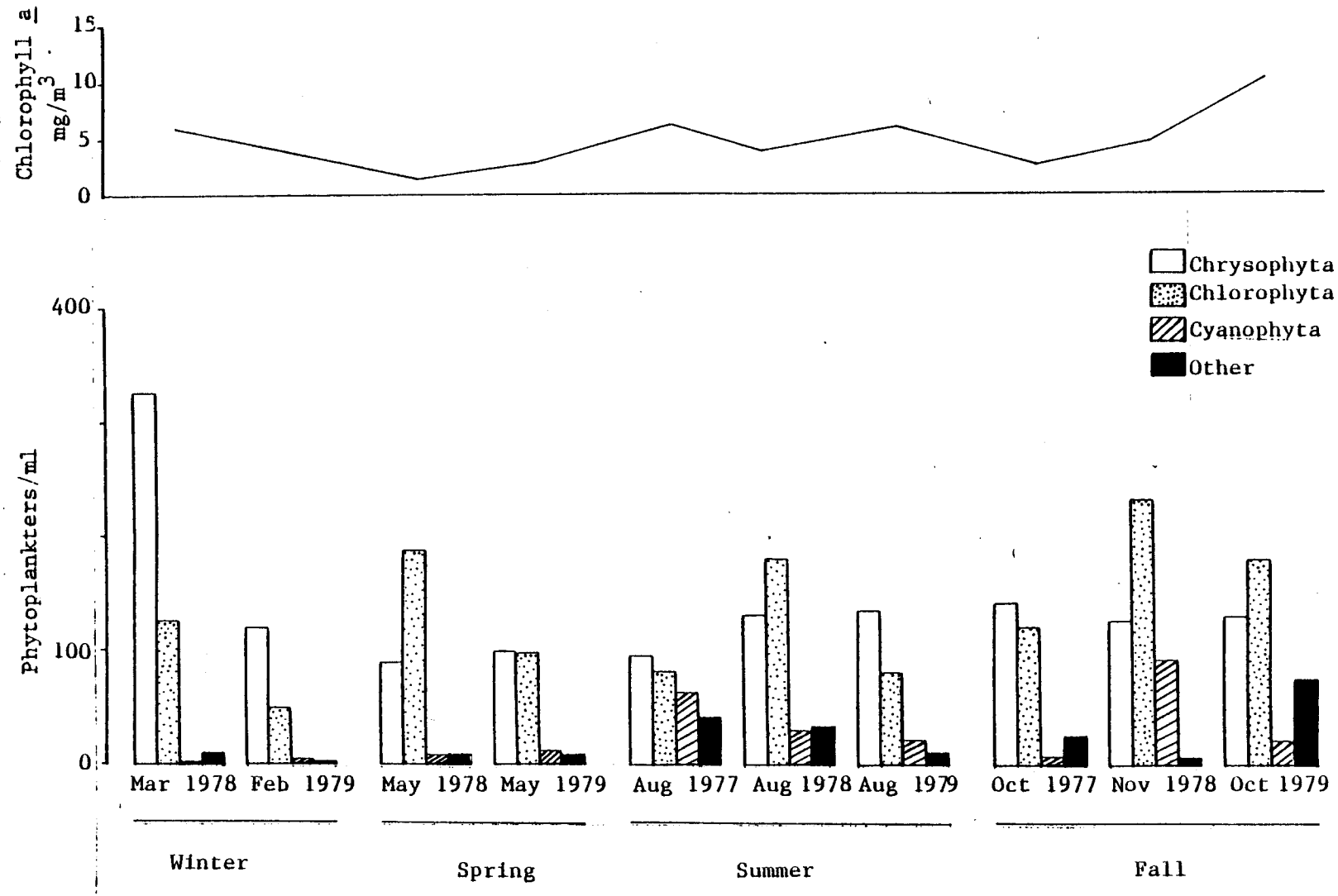


Figure III-3. Mean number of phytoplankters and chlorophyll concentrations encountered at all sampling stations on all sampling dates from 1977-79.

Table III-3

Dominance ranking of phytoplankton groups by sampling site and date. The most abundant group was assigned a value of one (1).

	Winter								Spring								Summer												Fall							
	Mar 1978				Feb 1979				May 1978				May 1979				Aug 1977				Aug 1978				Aug 1979				Oct 1977				Nov 1978				Oct 19		
Sampling site River Mile	Diatom	Green	Blue green	Other	Diatom	Green	Blue green	Other	Diatom	Green	Blue green	Other	Diatom	Green	Blue green	Other	Diatom	Green	Blue green	Other	Diatom	Green	Blue green	Other	Diatom	Green	Blue green	Other	Diatom	Green	Blue green	Other	Diatom	Green	Blue green	Other	Diatom	Green	Blue green
WRM 407.3	1	2	4	3	1	2	3	4	2	1	4	3	1	2	3	4	1	2	3	4	2	1	3	4	1	2	3	4	1	2	4	3	2	1	3	4	2	1	4
WRM 406.75	1	2	3	4	1	2	3	4	2	1	4	3	1	2	3	4	1	2	4	3	2	1	4	3	1	2	3	4	1	2	4	3	2	1	3	4	2	1	4
WRM 406.5	1	2	3	4	1	2	3	4	2	1	4	3	1	2	3	4	2	1	3	4	2	1	4	3	1	2	3	4	1	2	4	3	2	1	3	4	2	1	4

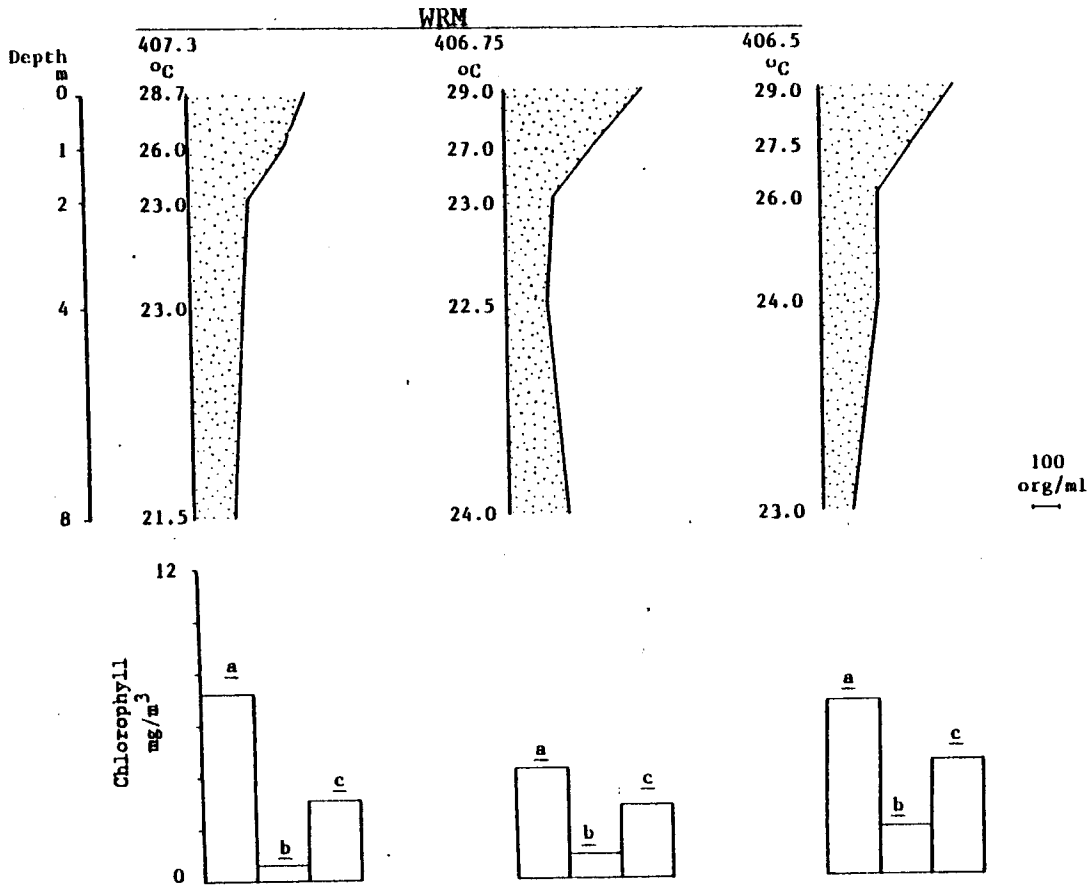


Figure III-4. Temperature profile, vertical distribution of phytoplankters (organisms/ml) and chlorophyll concentrations at each sampling station on 11 August 1977.

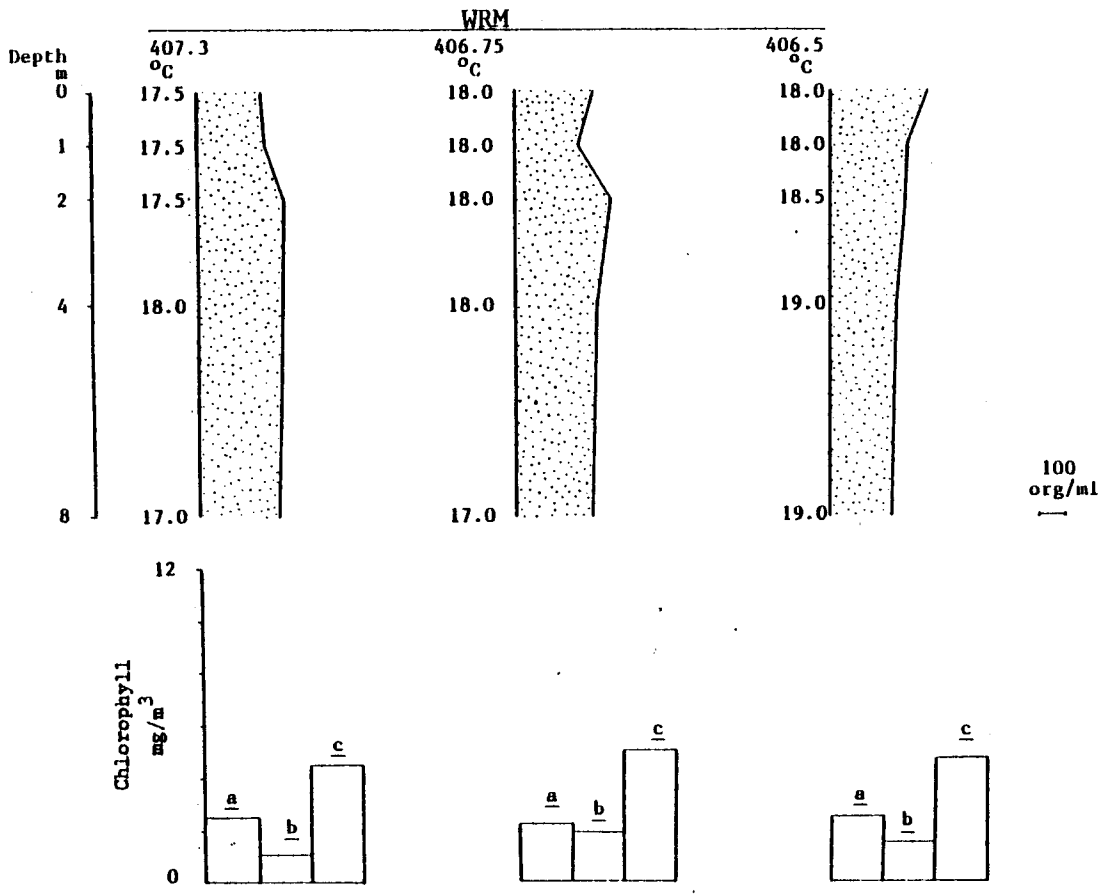


Figure III-5. Temperature profile, vertical distribution of phytoplankters (organisms/ml) and chlorophyll concentrations at each sampling station on 11 October 1977.

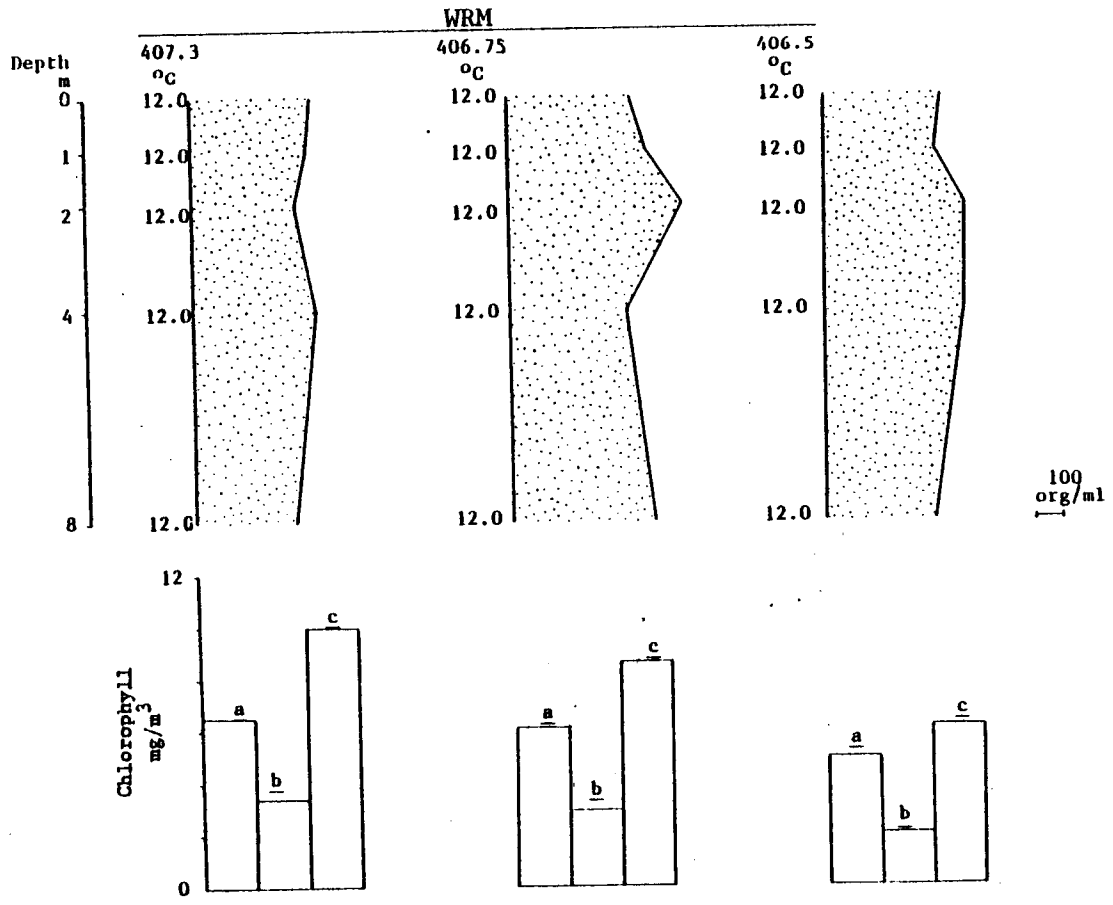


Figure III-6. Temperature profile, vertical distribution of phytoplankters (organisms/ml) and chlorophyll concentrations at each sampling station on 13 March 1978.

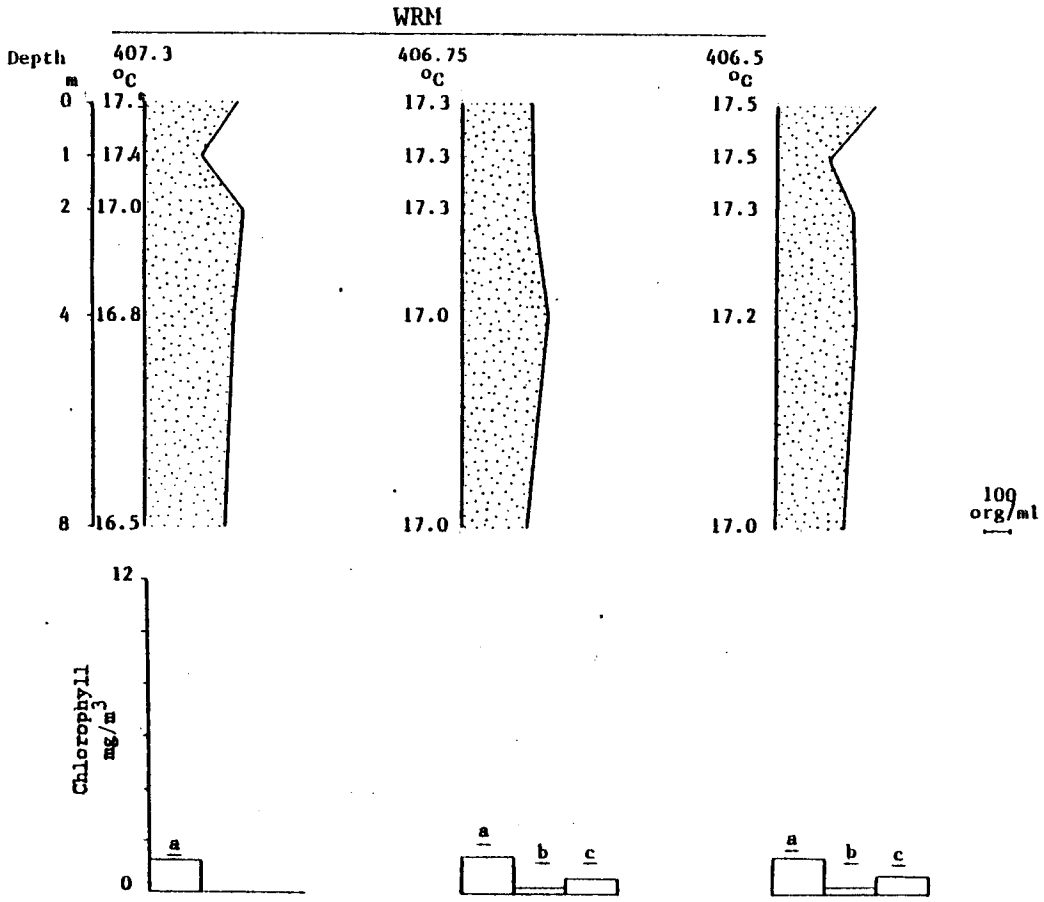


Figure III-7. Temperature profile, vertical distribution of phytoplankters (organisms/ml) and chlorophyll concentrations at each sampling station on 16 May 1978.

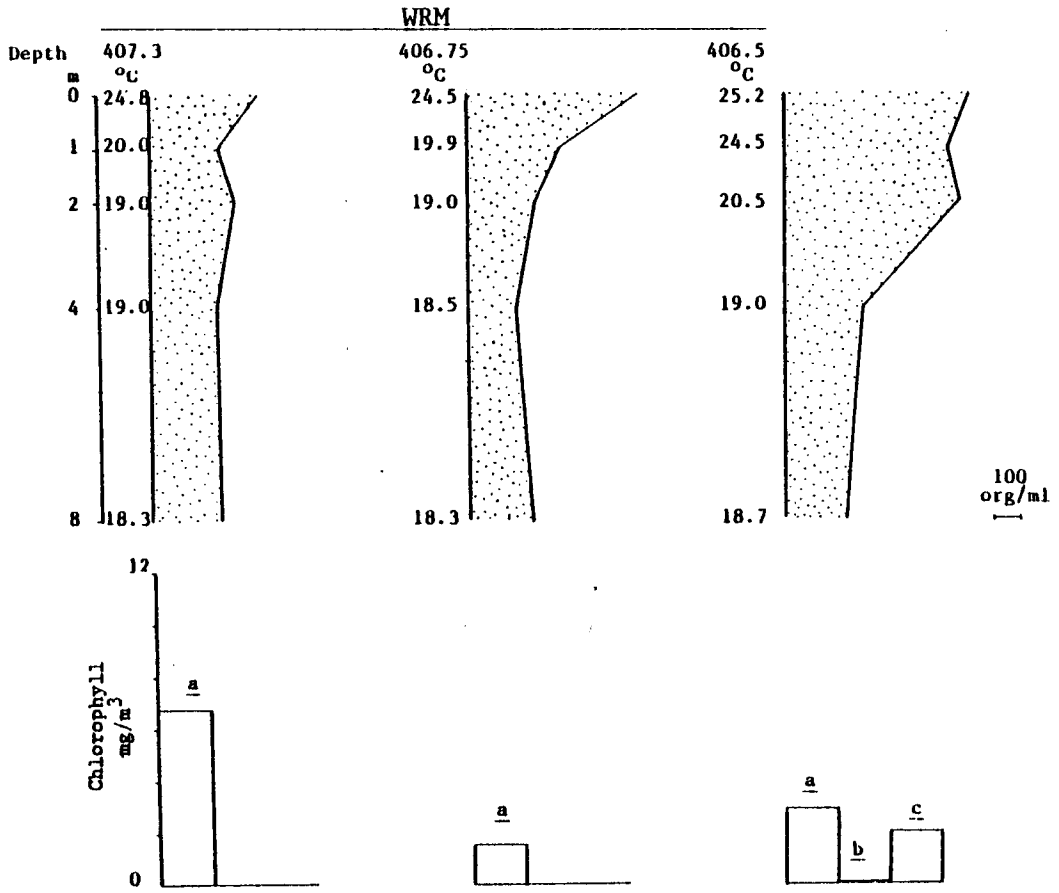


Figure III-8. Temperature profile, vertical distribution of phytoplankters (organisms/ml) and chlorophyll concentrations at each sampling station on 3 August 1978.

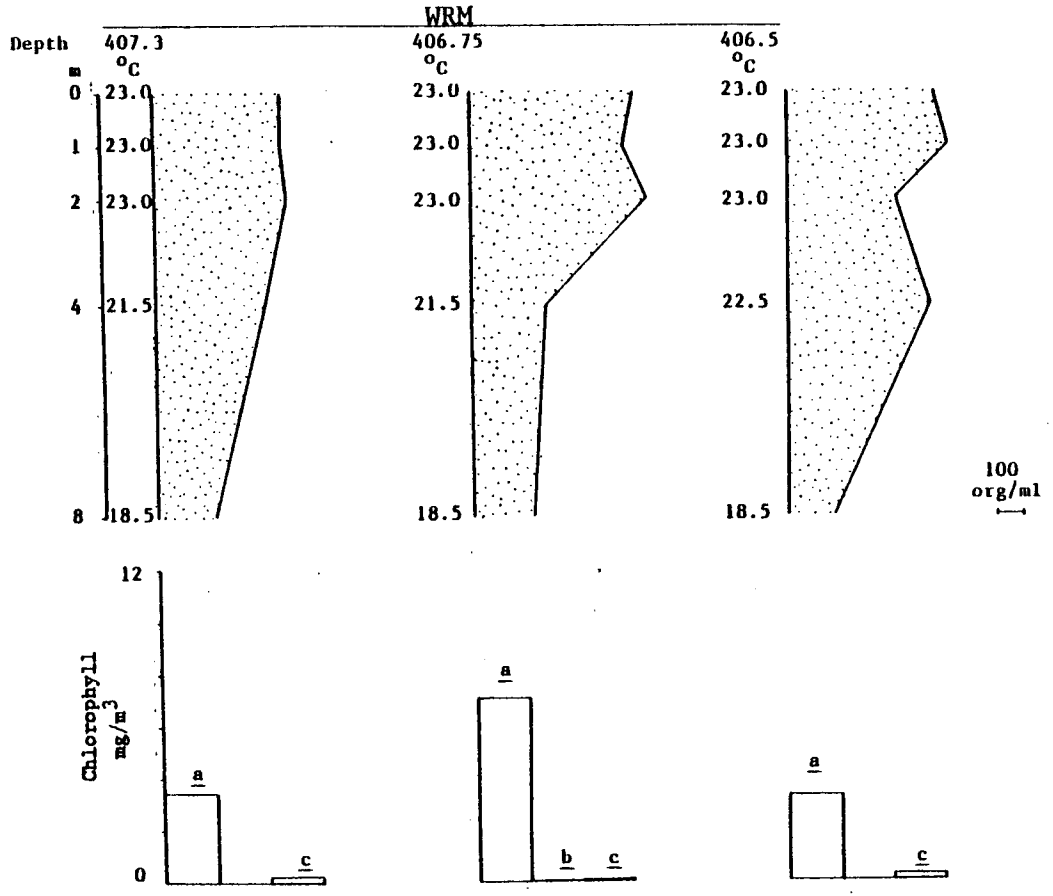


Figure III-9 Temperature profile, vertical distribution of phytoplankters (organisms/ml) and chlorophyll concentrations at each sampling station on 14 November 1978.

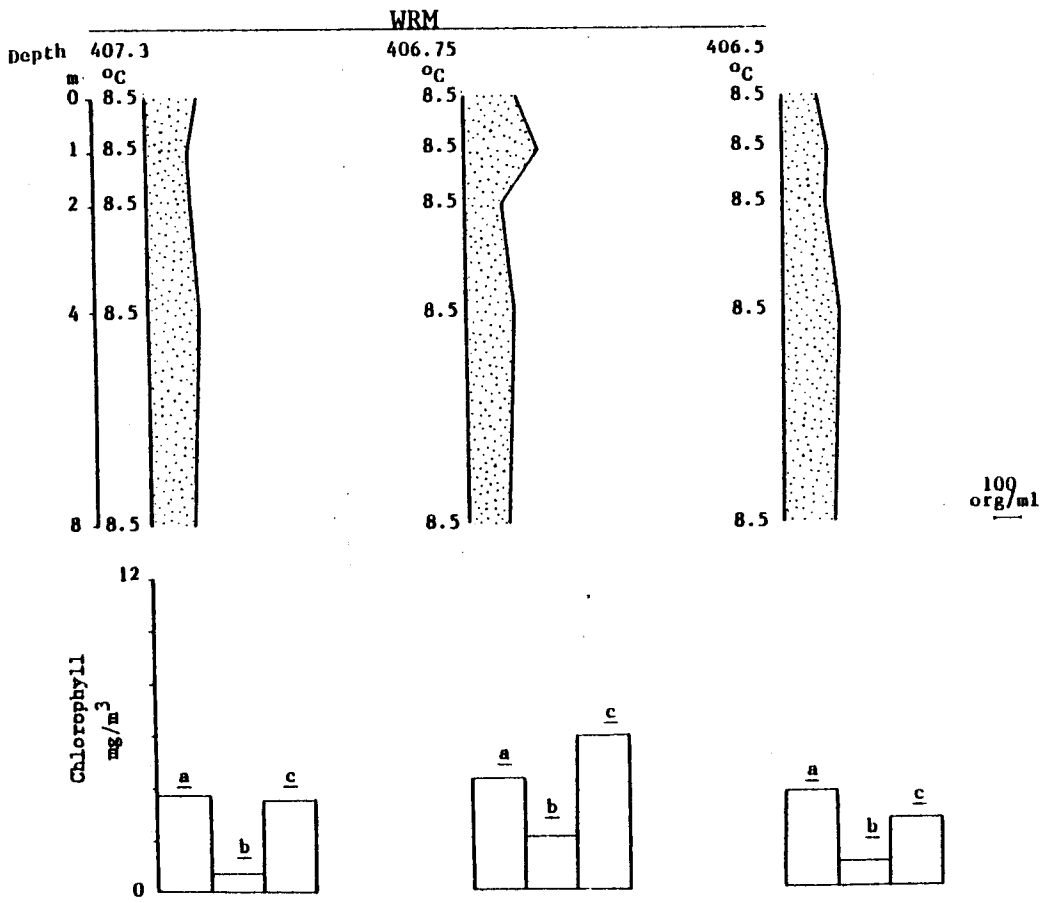


Figure III-10. Temperature profile, vertical distribution of phytoplankters (organisms/ml) and chlorophyll concentrations at each sampling station on 28 February 1979.

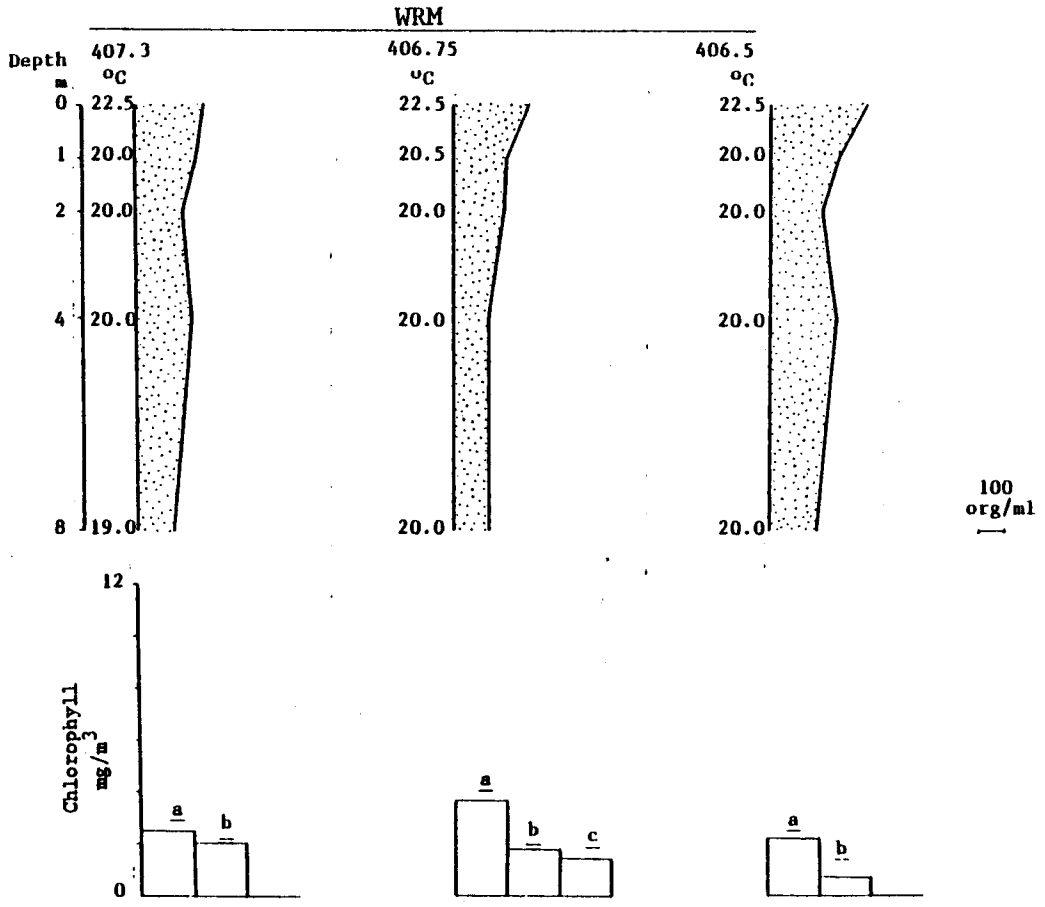


Figure III-11. Temperature profile, vertical distribution of phytoplankters (organisms/ml) and chlorophyll concentrations at each sampling station on 17 May 1979.

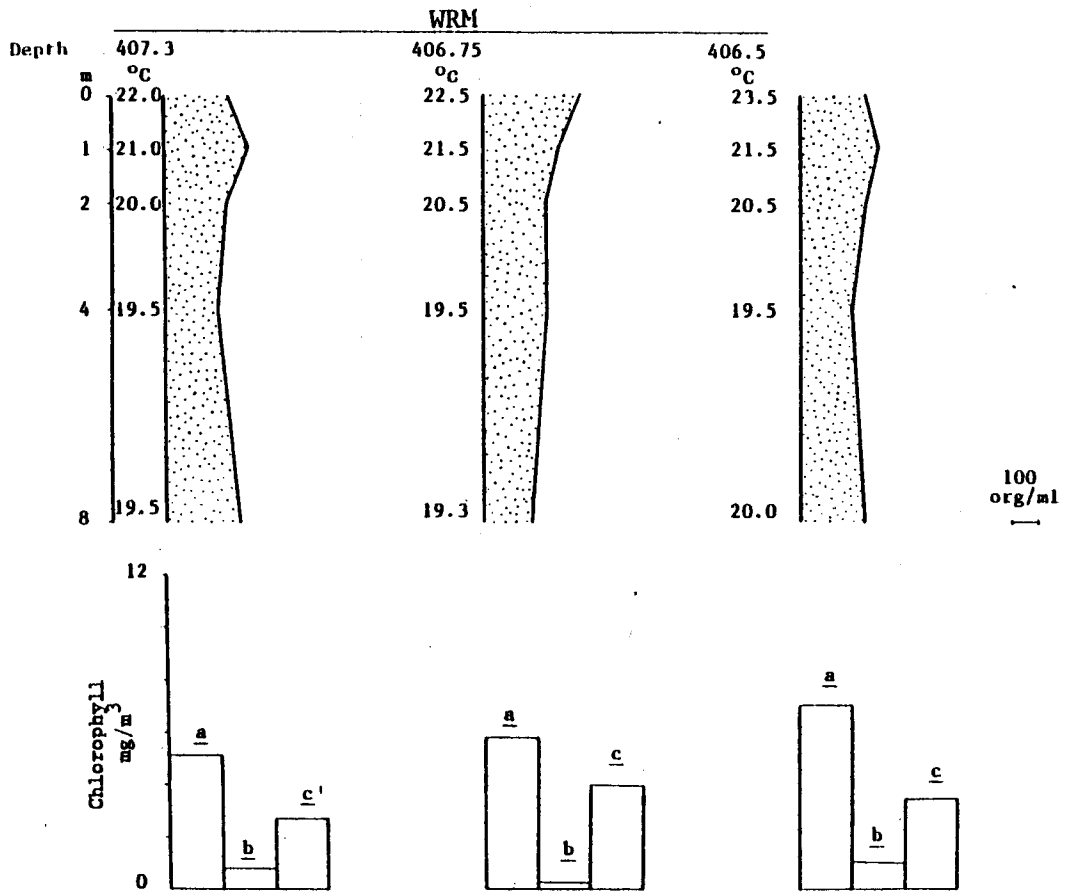


Figure III-12. Temperature profile, vertical distribution of phytoplankters (organisms/ml) and chlorophyll concentrations at each sampling station on 16 August 1979.

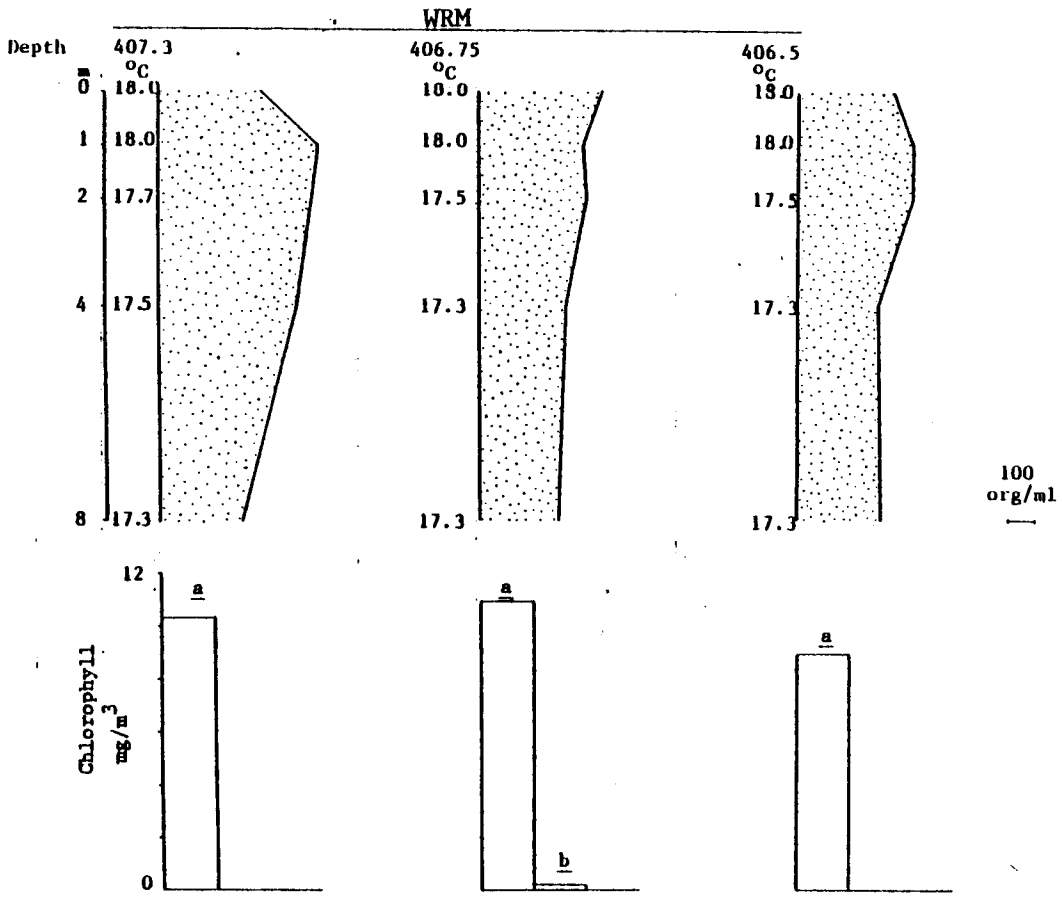


Figure III-13. Temperature profile, vertical distribution of phytoplankters (organisms/ml) and chlorophyll concentrations at each sampling station on 24 October 1979.

8 m depth and were frequently uniformly distributed in the water column.

A numerical dominance ranking of the plankton algae encountered by sampling station and date appears in Table III-4. Pennate diatoms were dominant in samples from at least two of the three stations on four of the ten sampling dates. Other commonly encountered yellow-green algae were Melosira granulata and Chrysococcus spp.. Dominant green algae included Chlamydomonas spp., Cosmarium spp., Scenedesmus quadricauda, Ankistrodesmus convolutus and A. falcatus. Oscillatoria spp. and Chroococcus spp. were the most commonly encountered blue-green algae. The dinoflagellates Gymnodinium sp. and Peridinium sp. were dominant forms from at least one station on two sampling dates. Although shifts in dominance during the course of the study did occur, there appear to be no biologically significant differences between sampling stations on any given date.

Results of this study have failed to demonstrate any measurable qualitative or quantitative effects of the operation of the Miller Steam Plant on phytoplankton communities of the Mulberry Fork of the Black Warrior River near the water intake structure of this plant.

Zooplankton

Zooplankton densities varied seasonally as illustrated in Figure III-14. With the exception of 11 October 1977 the summer and fall samples contained the highest concentrations of zooplankters. The highest turbidities encountered during this study, a mean of 37.7 JTU's, occurred in October 1977 and apparently reduced the standing crop of

zooplankters far below what would be expected for this season of the year. Zooplankton densities ranged from a low of 10 organisms/l 16 May 1978 to a high of 534 organisms/l 24 October 1979.

The abundance and vertical distribution of zooplankters in the water column at each station on each sampling date are illustrated in Figures III-15 through III-19. Patterns of distribution varied considerably between sampling dates but variations between stations on any given date were minimal.

Dominant zooplankters encountered during this study are presented in Table III-5. The most abundant and frequently occurring organisms were: Keratella cochlearis, Conochilus unicornis, Polyarthra spp., Cyclops spp., Diaptomus spp., Bosmina longirostris and Ceriodaphnia lacustris.

Diversity ($\bar{d}$) and equitability (e) indices were calculated for zooplankton communities at each station on each sampling date (Table III-6) (Weber 1973). A hypothetical community consisting of 100 organisms evenly divided among 10 taxa would have a $\bar{d}$ = 3.32 and an e = 1.43, whereas a community of 100 organisms with 90 in one taxon and 10 in the other would have a $\bar{d}$ = 0.47 and an e = 0.75. Seasonal changes in environmental conditions caused considerable variation in $\bar{d}$ and e values between sampling dates. However, on any given date, organism density, number of taxa, $\bar{d}$ and e values were usually similar at all stations.

Based on the results of this study there appears to be no evidence that the entrainment of organisms by Miller Steam Plant has had detectable adverse effect on zooplankton communities in the adjacent Black Warrior River.

Table III-4

Dominance ranking of phytoplankters encountered by sampling station and date. The most abundant organism was assigned a value of one (1).

	1977						1978								
	10 Aug			11 Oct			13 March			16 May			3 Aug		
Organism / Station Number	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CHRYSOPHYTA															
Pennate diatom	4	3	4	2	2	2	1	1	1	5	3	2	2	5	4
Melosira granulata							4	4	4					4	
M. varians															
Cyclotella sp.													5		5
Chrysococcus sp.															
Dinobryon sp.															
Pseudotetraedron neglectum															
CHLOROPHYTA															
Ankistrodesmus sp.															
A. convolutus	2		2											3	
A. falcatus										4	4				
A. nannoselene												3	4		
Scenedesmus sp.		4													
S. quadricauda				1	1	1								1	2
S. acuminatus															
S. armatus															
S. denticulatus															
S. bijuga															
Pandorina charkowiensis															
P. morum															
Dictyosphaerium sp.															
Eudorina elegans															
Actinastrum hantzschii															
Closterium sp.											5				
Cosmarium sp.							2	2	2	3	2	4	3		
Arthrodesmus sp.												5			
Sphaerocystis sp.															
Kirchneriella sp.															
Chlamydomonas sp.				3	3	3	3	3	3	2			1	2	
Crucigenia sp.															
Pediastrum duplex															
Schroederia sp.															
Staurastrum sp.															
Unid. green flagellate										1	1	1			3
Coelastrum sp.															
CYANOPHYTA															
Anabaena sp.															
Gomphosphaeria sp.	5		5												
Merismopoedia sp.															
Oscillatoria angustissima															
Oscillatoria sp.	1	1	1												
Chroococcus sp.															
EUGLENOPHYTA															
Trachelomonas sp.	3	5	3												
Phacus sp.															
PYRRHOPHYTA															
Gymnodinium sp.															
Peridinium sp.															1
Unid. dinoflagellate		2													

Table III-4, continued

Organism / Station Number	1978 14 Nov 1	14 Nov 2	14 Nov 3	1979 28 Feb 1	28 Feb 2	28 Feb 3	17 May 1	17 May 2	17 May 3	17 Aug 1	17 Aug 2	17 Aug 3	24 Oct 1	24 Oct 2	24 Oct 3
CHRYSOPHYTA															
Pennate diatom	1	5	1	1	1	1	3	4	2	1	1	1	2	2	2
Melosira granulata											5			5	
M. varians											5				
Cyclotella sp.	5		5				2	1	1	2	2			5	
Chrysococcus sp.												4	4		4
Dinobryon sp.															
Pseudotetraedron neglectum															
CHLOROPHYTA															
Ankistrodesmus sp.															
A. convolutus	3														
A. falcatus				3	2	2	4	4	5	5			4	4	
A. nannoselene						4			3	4					
Scenedesmus sp.															
S. quadricauda	2		2					5			5		3	5	
S. acuminatus								5							
S. armatus															
S. denticulatus				4											
S. bijuga		3					5	5				5			
Pandorina charkowiensis															
P. morum															
Dictyosphaerium sp.															
Eudorina elegans															
Actinastrum hantzschii															
Closterium sp.															
Cosmarium sp.					4			3							
Arthrodesmus sp.															
Sphaerocystis sp.															
Kirchneriella sp.															
Chlamydomonas sp.	4	1	4	2	3	3	1	2			3	5		3	3
Crucigenia sp.											5				
Pediastrum duplex															
Schroederia sp.															
Staurastrum sp.										5					
Unid. green flagellate															
Coelastrum sp.		4													
CYANOPHYTA															
Anabaena sp.				5											
Gomphosphaeria sp.															
Merismopedia sp.															
Oscillatoria angustissima										5			5	4	5
Oscillatoria sp.															
Chroococcus sp.		2	3						4	3	4	2			5
EUGLENOPHYTA															
Trachelomonas sp.													4		
Phacus sp.															
PYRRHOPHYTA															
Gymnodinium sp.												3	1	1	1
Peridinium sp.													4		
Unid. dinoflagellate															

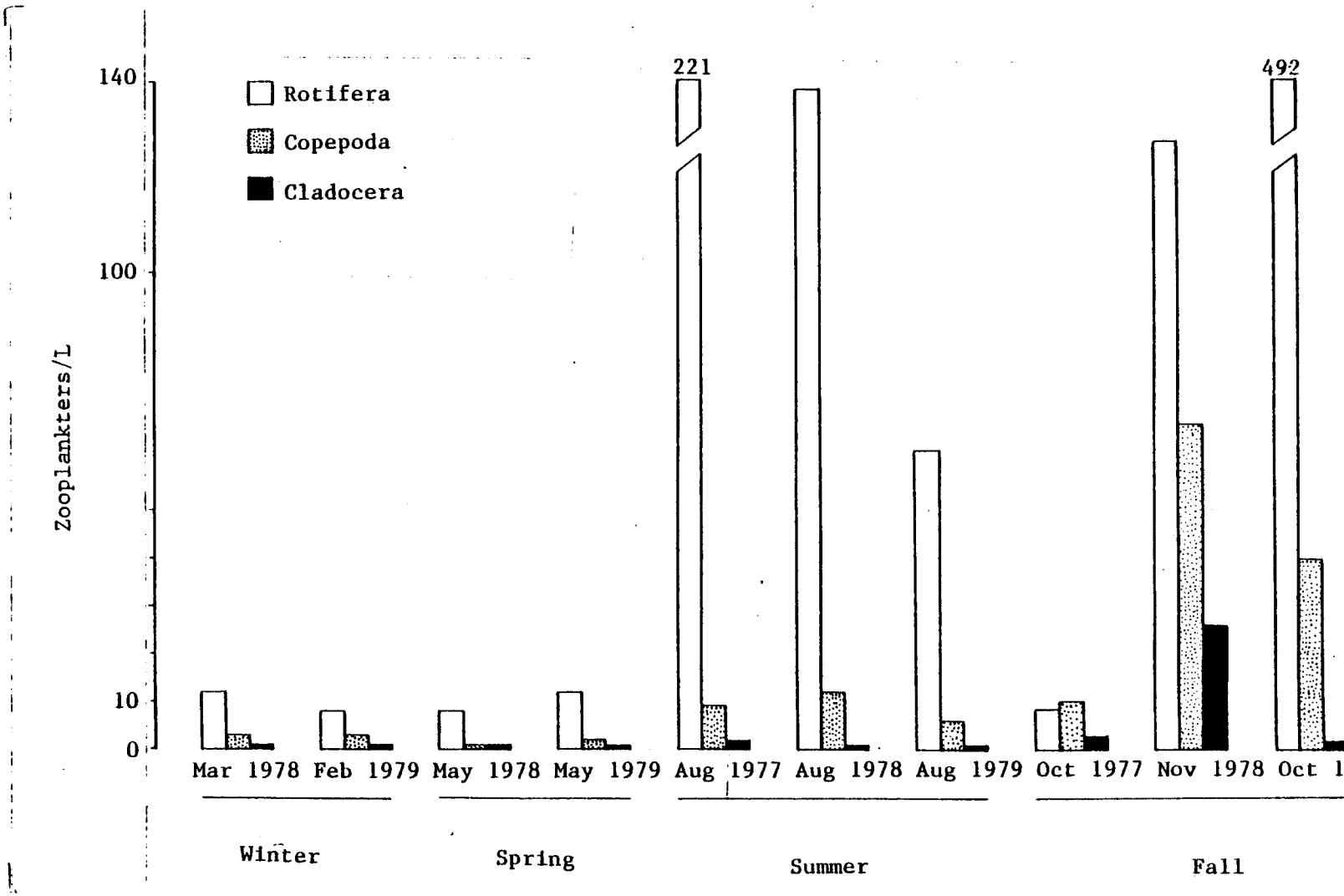


Figure III-14.. Mean number of zooplankters encountered at all stations sampled on each sampling date fro
1977 to 1979.

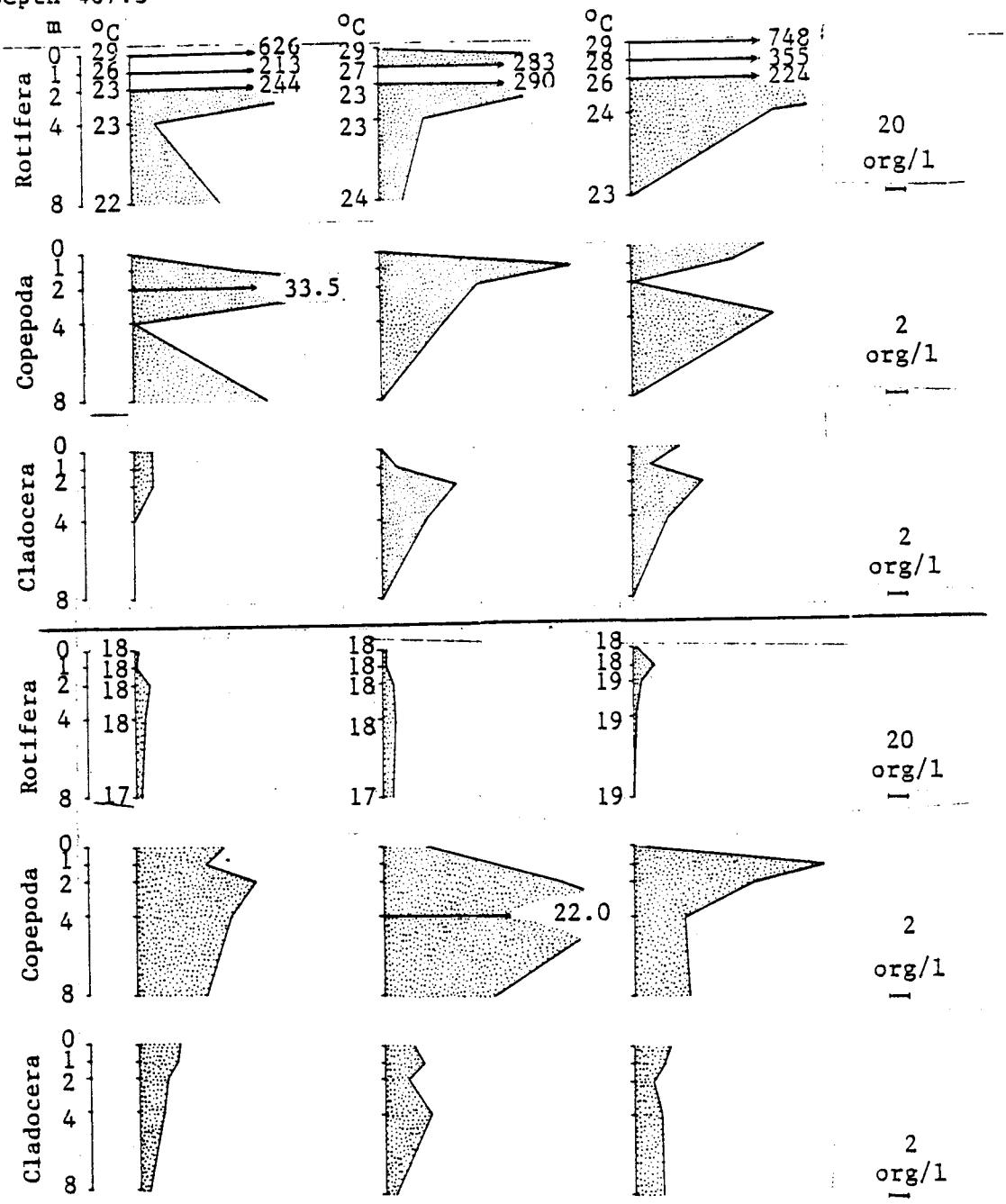


Figure III-15. Temperature profile and vertical distribution of zooplankters (organisms/1) at each sampling station on 11 August 1977 (upper) and 11 October 1977 (lower).

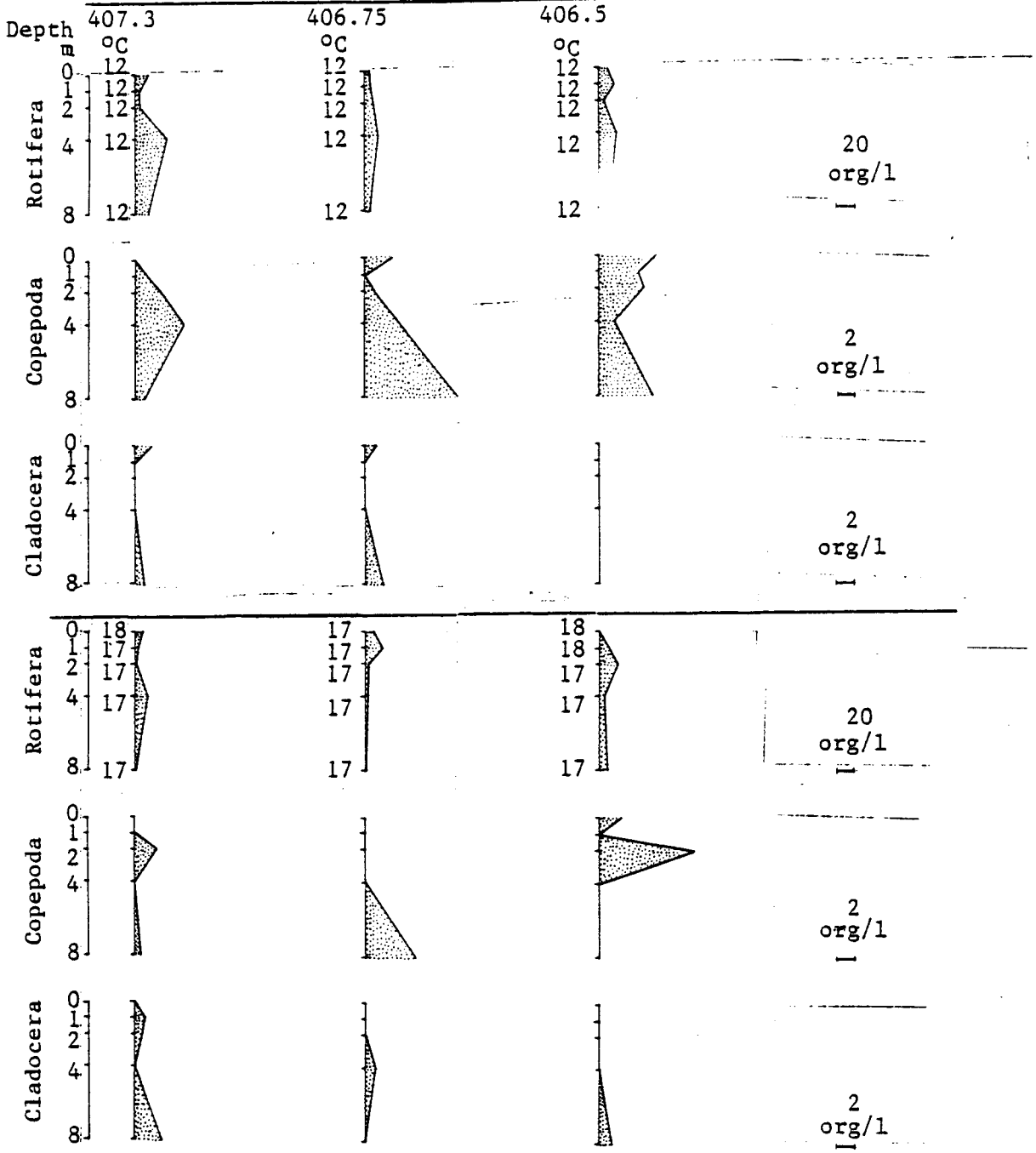


Figure III-16. Temperature profile and vertical distribution of zooplankters (organisms/l) at each sampling station on 13 March 1978 (upper) and 16 May 1978 (lower).

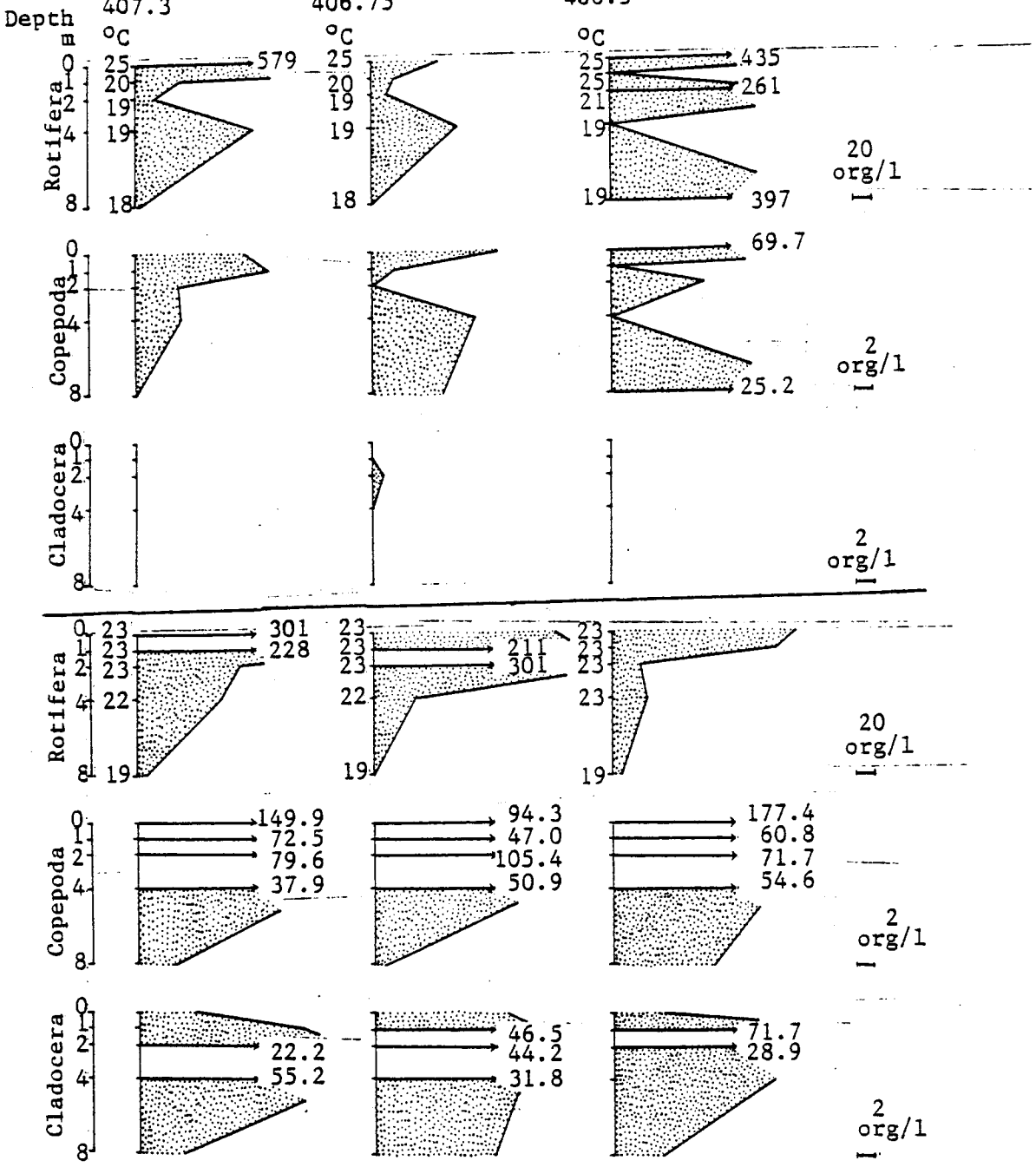


Figure III-17. Temperature profile and vertical distribution of zooplankters (organisms/1) at each sampling station on 3 August 1978 (upper) and 14 November 1978 (lower).

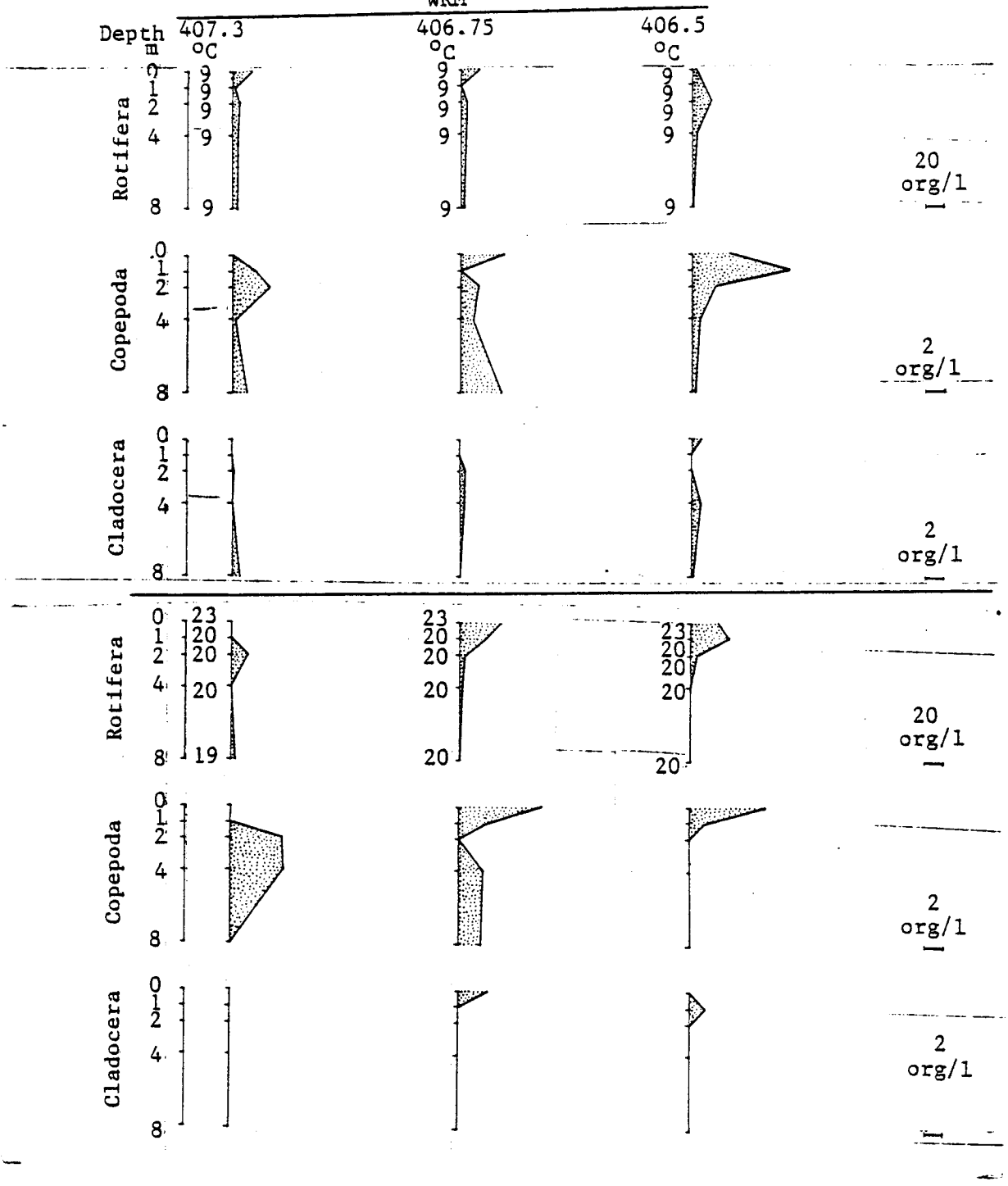


Figure III-18. Temperature profile and vertical distribution of zooplankters (organisms/l) at each sampling station on 28 February 1979 (upper) and 17 May 1979 (lower).

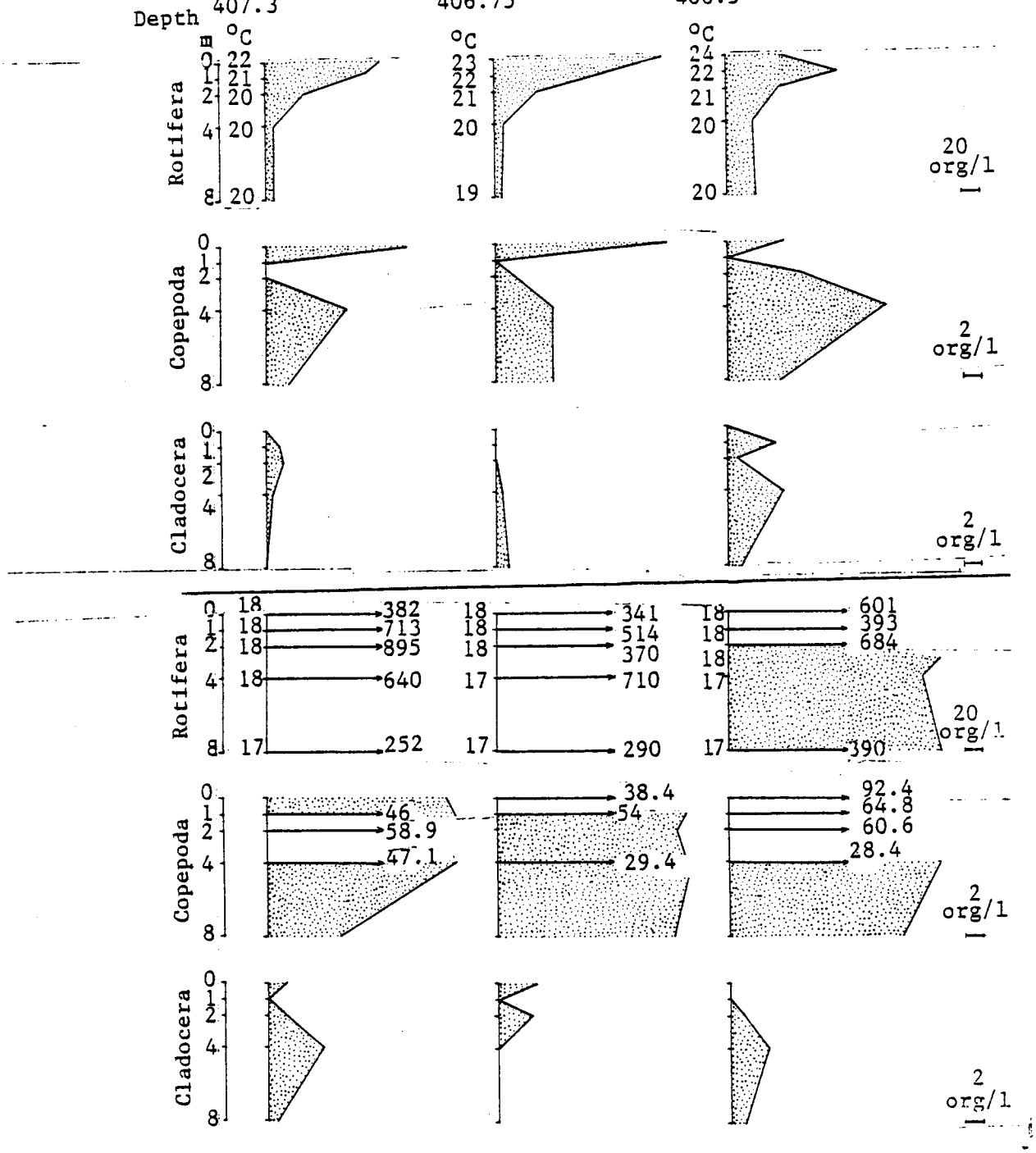


Figure III-19. Temperature profile and vertical distribution of zooplankters (organisms/l) at each sampling station on 16 August 1979 (upper) and 24 October 1979 (lower).

Table III-5

Dominance ranking of zooplankters by sampling station and date. Most abundant organism in each major group was assigned a value of one (1).

	1977						1978								
	10 Aug			11 Oct			13 March			16 May			3 Aug		
Organism / Station Number	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
ROTIFERA															
Keratella cochlearis	3			1	3		2	2		1					
Conochilus unicornis		3			1	2	1	3	2				3	3	
Polyarthra sp.						3	3			3			2		3
Synchaeta sp.								1		3	3				
Brachionus sp.	2		1/3*	3						2		3			
Keratella sp.											2	1	1	1	2
Unidentified rotifer									1	2	1	2		2	
Ploesoma sp.	1	1	2												
Kellicottia bostoniensis					2	1									
Filinia sp.					3				3						1
Asplanchna sp.															
Conochiloides sp.				2											
Keratella quadrata										2					
Lecane sp.															
Trichocerca sp.		2													
COPEPODA															
Immature (nauplii)	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1
Cyclops sp.	3		2	2	2	2	3	2	3	2			2	2	2
Diaptomus sp.	2	2	2	3	3	3	1	3	2				3	3	3
CLADOCERA															
Bosmina longirostris	2	3	2	1	1	1	1				1			1	
Ceriodaphnia lacustris			2	2	2	2									
Holopedium amazonicum															
Daphnia sp.						3		1		1		1			
Diaphanosoma leuchtenbergianum															
Bosminopsis deitersi	1	1	1												
Pseudosida bidentata		2	3		3										
Alona sp.				3											
Alonella acutirostris										2					
Chydorus sphaericus								2							
Daphnia parvula															

*Numbers separated by a slash (/) indicate shared dominance between two or more species of that genus.

Table III-5, continued

Organism / Station Number	1978 14 Nov 1	2	3	1979 28 Feb 1	2	3	17 May 1	2	3	17 Aug 1	2	3	24 Oct 1	2	3
ROTIFERA															
Keratella cochlearis	1	1	1	2	2	3	1	1	1	1	1	1	3	1	2
Conochilus unicornis	3	3	3			2	2	3				2	2	3	3
Polyarthra sp.	2	2	2	3	1	1	2	2	2	3	2	3			
Synchaeta sp.				1					2	2	3		1	2	1
Brachionus sp.							2/2/2		3						
Keratella sp.							2								
Unidentified rotifer															
Ploesoma sp.															
Kellicottia bostoniensis															
Filinia sp.															
Asplanchna sp.															
Conochiloides sp.															
Keratella quadrata					3										
Lecane sp.															
Trichocerca sp.															
COPEPODA															
Immature (nauplii)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cyclops sp.	2	3	3	2	2/3	3	2	2	2	2	2	3	2/3	2/3	2/3
Diaptomus sp.	3	2	2	3	3	2				3	3	2			
CLADOCERA															
Bosmina longirostris	1	1	1	1	1	1		1		1	2	1	2	1	1
Ceriodaphnia lacustris									1				3		3
Holopedium amazonicum		3							1	2	1	2			3
Daphnia sp.															2
Diaphanosoma leuchtenbergianum	2	2	2										1		
Bosminopsis deitersi															
Pseudosida bidentata															
Alona sp.															
Alonella acutirostris															
Chydorus sphaericus															
Daphnia parvula			3												

(e) of zooplankton communities by season or year, sampling date, time and station.*

Season Date	Sampling Station	Organisms/L	Number of Taxa	$\bar{d}$	e
WINTER					
13 Mar 1978	1	17.0	10	3.06	1.20
	2	10.0	9	2.78	1.11
	3	13.4	10	3.05	1.20
28 Feb 1979	1	8.7	15	3.25	0.93
	2	7.6	11	2.52	0.73
	3	13.5	12	2.92	0.92
SPRING					
16 May 1978	1	7.4	10	3.15	1.30
	2	7.4	5	1.88	1.00
	3	9.0	5	1.98	1.00
17 May 1979	1	4.7	8	2.08	0.75
	2	17.8	8	2.40	0.88
	3	16.3	10	2.48	0.80
SUMMER					
11 Aug 1977	1	241.0	16	2.90	0.63
	2	132.6	18	3.40	0.83
	3	297.8	20	3.25	0.70
3 Aug 1978	1	156.2	14	1.27	0.21
	2	51.6	14	2.56	0.57
	3	221.4	16	2.45	0.44
16 Aug 1979	1	60.6	15	2.78	0.67
	2	72.0	17	2.78	0.59
	3	61.4	15	2.95	0.73
FALL					
11 Oct 1977	1	14.9	16	3.39	0.94
	2	15.2	14	3.50	1.14
	3	11.4	10	3.00	1.10
14 Nov 1978	1	174.8	14	2.25	0.43
	2	174.8	15	2.07	0.40
	3	117.4	12	2.21	0.50
24 Oct 1979	1	586.1	23	2.79	0.43
	2	456.3	18	2.92	0.61
	3	469.2	25	2.77	0.36

*Information presented does not include immature copepods.

Fishes in Mulberry Fork of the Black Warrior River can be classified generally as warm water species, which will spawn anywhere the habitat is suitable. A larval fish monitoring program was conducted on the Black Warrior River in the vicinity of the J. H. Miller river water intake during the Spring of 1978 and 1979. The purpose of the larval fish study was to determine larval fish densities and population composition relative to assessing possible entrainment effects associated with Unit 1 operation at the plant.

Larval fish monitoring on the Mulberry Fork of the Black Warrior River was conducted during the Spring of 1978, which provided data prior to the operation of Unit No. 1, and during the Spring of 1979, a period during which intake pumps and Unit No. 1 were operational. Larval fish populations were sampled at three locations during the 1978 study period and at four locations during the 1979 study period. Sample stations during the 1978 study period included: (1) an upstream sample station located approximately .5 miles above the plant intake, (2) a station located in Burnt Cane Creek, a stream located approximately .3 miles upstream of the plant intake, and (3) a sample station located approximately 0.6 miles downstream from the plant intake (See Figure III-20). Sample stations used during the 1979 sample period were the same as those used during 1978 with the exception of an additional station at the river water pump discharge, located at the transfer pond.

Larval fish were collected every two weeks, beginning in March and extending through August during both the 1978 and 1979 sample years. Samples collected at the two river stations were obtained from depths of 5, 10 and 15 feet while samples collected in Burnt Cane Creek were obtained from only the 5 foot

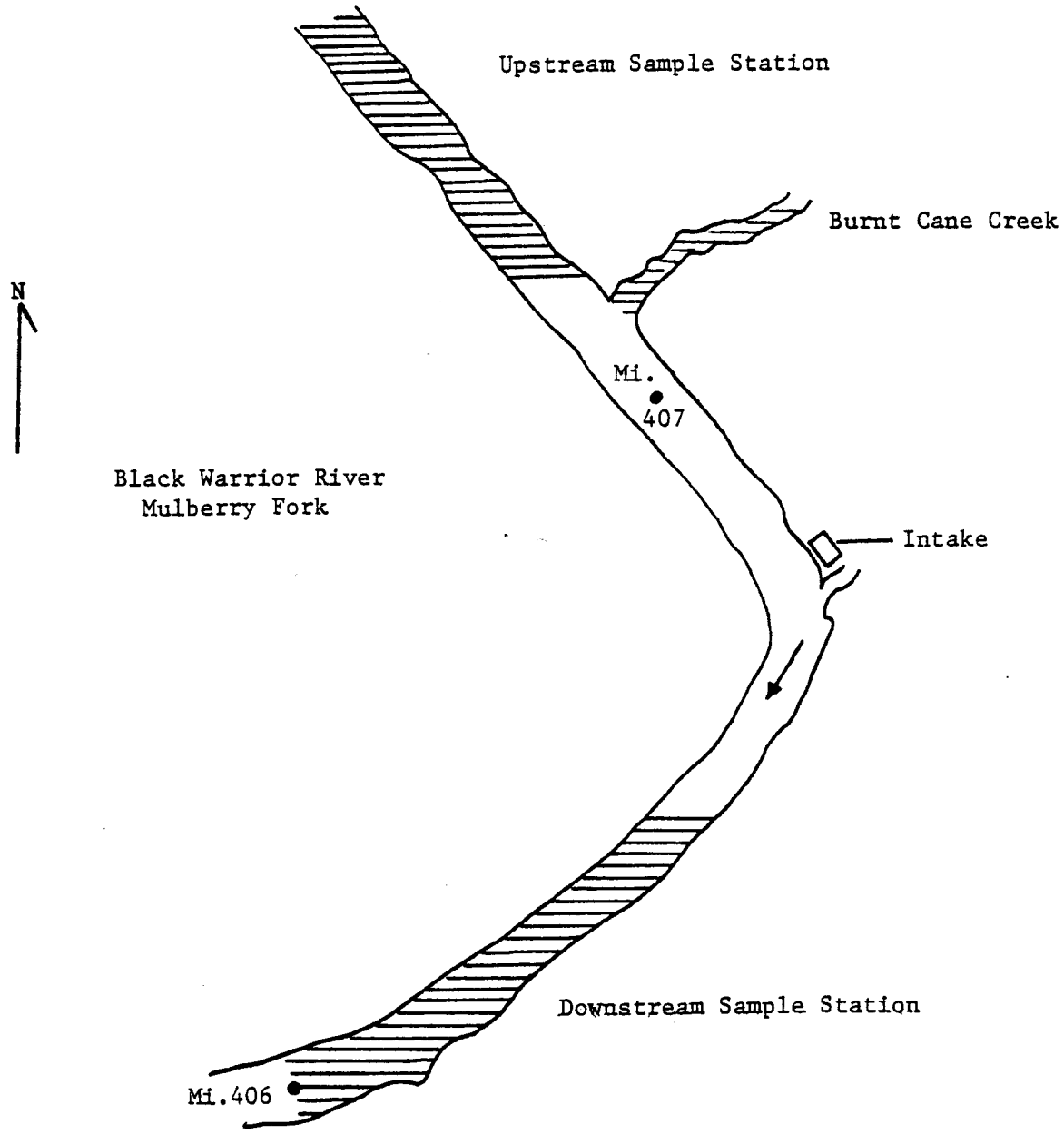


FIGURE III-20 Locations of Larval Fish amd Macroinvertebrate Sampling Stations on the Black Warrior River.

depth due to shallow water conditions. Sampling at the river water pump discharge (located at the transfer pond) was accomplished by placing the collection net in the discharge plume.

Collection equipment used for larval fish monitoring included a sample net with attached flowmeter. Larval fish nets were constructed of 510 micron netting and were of conical shape with a 0.5 meter opening and a length of 1.5 meters. Net mounted flowmeters were utilized for all samples to provide data relative to volumes of water filtered.

Results and Discussion

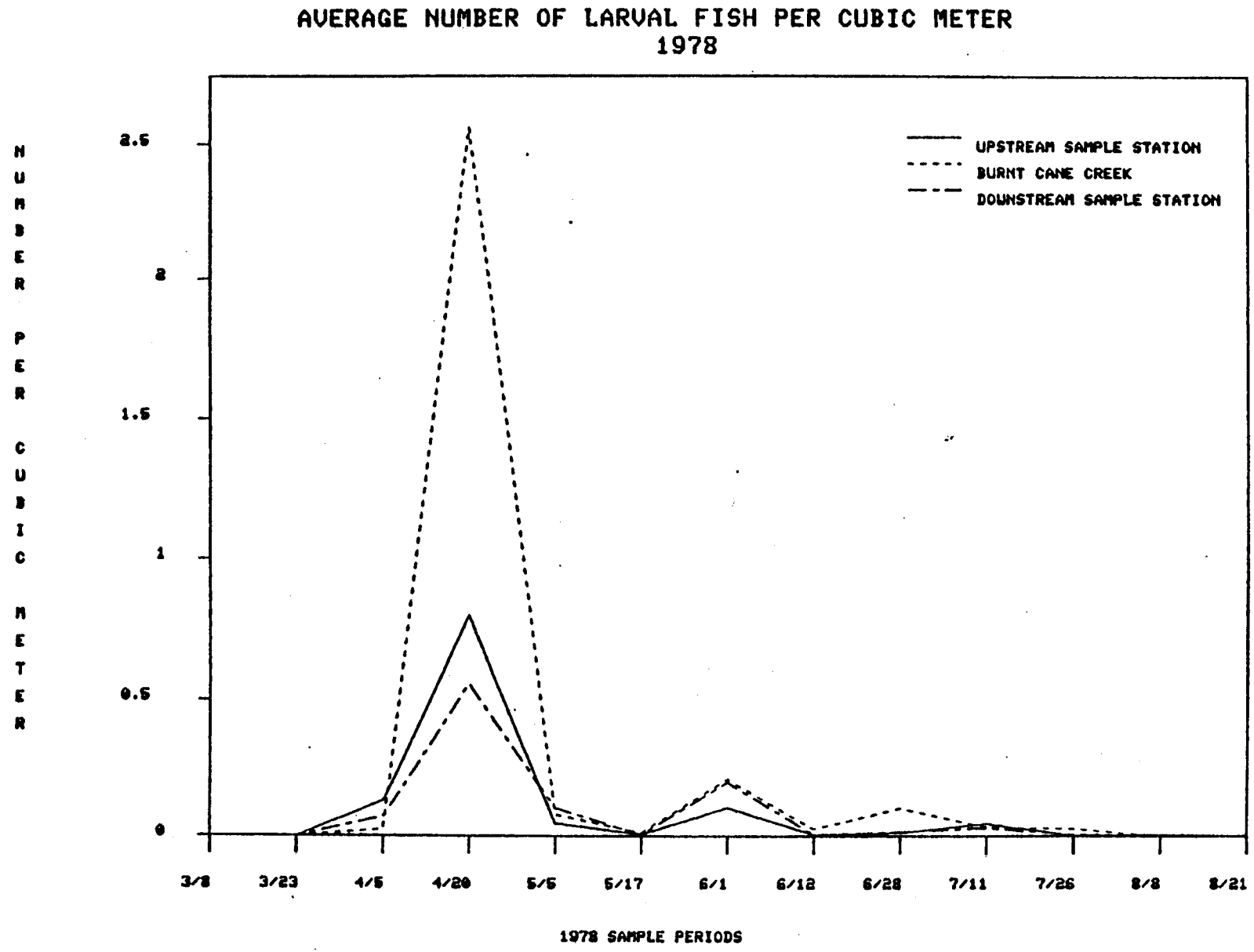
Average larval fish densities in the upstream and downstream sample areas were found to be similar during the 13 sample periods in 1978 (see Table III-7). Larval fish densities observed in Burnt Cane Creek, which enters the river just upstream of the intake, were also found to be similar to river densities with the exception of sample period during which peak densities occurred. Densities in Burnt Cane Creek were approximately four times the densities of larval fish in the river stations on the April 20, 1978 sample date. Peak larval fish densities observed in each sample area occurred on the April 20 sample date during the 1978 spawning season. The average density of larval fish in each sample area for each sample date during the 1978 study is depicted in Figure III-21.

Larval fish densities observed during the 1979 spawning period (see Table III-7) indicated a delayed spawning period as compared to the 1978 data. River temperatures observed during the Spring of 1979 were considerably lower than temperatures observed during the same period in 1978, which probably resulted in the delayed spawning season. Peak larval fish densities were

Sample Date	Average Number of Larvae Per Cubic Meter			
	Upstream[1]	Burnt Cane Creek[2]	Downstream[3]	Intake Pipe Discharge[4] (Pumps inoperative during 1978)
3/8/78	0	0	0	
3/23/78	0	0	0	
4/5/78	0.132	0.026	0.074	
4/20/78	0.801	2.564	0.559	
5/5/78	0.047	0.081	0.106	
5/17/78	0.006	0.014	0.007	
6/1/78	0.107	0.213	0.202	
6/12/78	0.006	0.027	0.007	
6/28/78	0.013	0.106	0.017	
7/11/78	0.048	0.035	0.032	
7/26/78	0.003	0.028	0.007	
8/8/78	0.006	0	0	
8/21/78	0	0	0.002	
?/9/79	0	0	0	NS
/21/79	0	0	0	NS
4/5/79	0.003	0	0	NS
4/19/79	0.005	0	0.002	0
5/1/79	0.013	0.029	0.009	0.091
5/15/79	0.467	0	0.266	0
5/31/79	0.034	0.015	0.016	0.034
6/13/79	0.044	0.014	0.045	0.041
6/27/79	0.004	0.026	0.011	0.100
7/12/79	0.007	0.069	0.006	0.020
7/26/79	0.003	0	0.002	0.013
8/7/79	0.002	0.013	0.005	0.016
8/22/79	0	NS	0.003	0.015

1. Upstream Sample Area----------WRM 407.3-407.8
2. Burnt Cane Creek----------WRM 407.1
3. Downstream Sample Area----------WRM 406.0-406.5
4. Intake Pipe Discharge----------Discharge Point at Storage Pond

FIGURE III-21

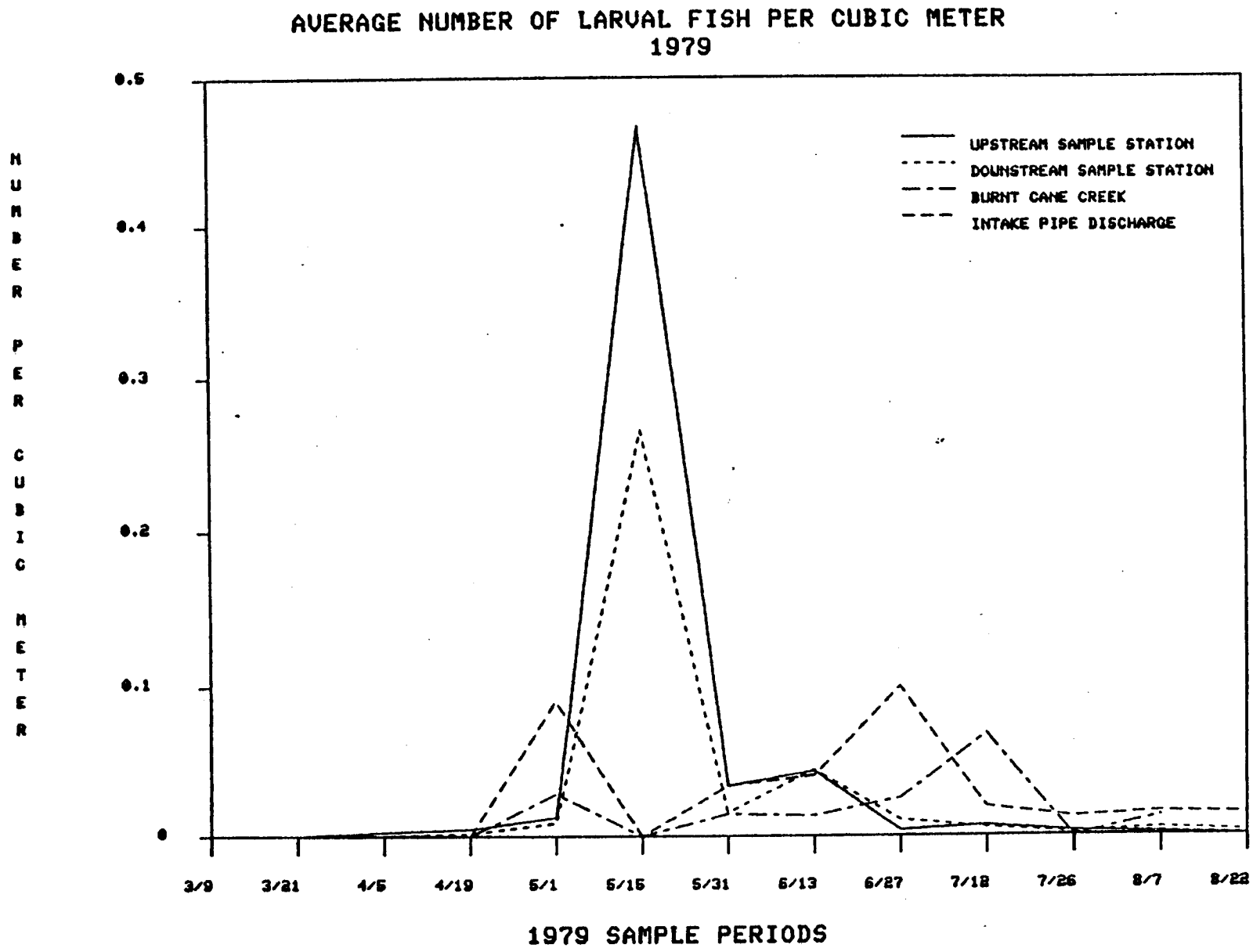


observed on the May 15 sample date (Figure III-22) for the upstream and downstream sample areas. Larval fish densities in all sample areas were lower during the 1979 sample year than densities observed during the 1978 sample year.

Larval fish densities observed in the river water pump effluent (see Table III-7) did not indicate significant numbers of larvae were being removed from the river, nor did densities of larvae in the pump effluent coincide with differences observed between densities of larvae upstream of the intake and densities downstream of the intake. The Student's "T" statistic, utilizing a paired sample analysis, was used to compare larval fish densities upstream of the intake with densities observed downstream of the intake. The results of the statistical evaluation indicated no significant difference existed between larval fish densities in the two sample stations using a 95% confidence limit.

Larval fish collected during the study were identified to Family, and the percent represented by each Family of the total larvae collected computed (Tables III-8 and III-9). The Family Clupeidae (herring Family), which includes the shad (Dorosoma sp.) was found to be dominant in all sample areas during the 1978 sample year. The Clupeidae were also dominant in all sample areas during the 1979 sample year, with the exception of the Burnt Cane Creek sample area. The next most dominant groups of larvae identified were of the Families Centrarchidae, Cyprinidae and Catostomidae. Other Families identified during the study are presented in Tables III-8 and III-9. The total number of fish collected from each sample area is also presented in the previously referenced tables. The distribution of larvae among the various taxa identified does not indicate any significant differences in taxa identified from the upstream sample station and larvae taxa identified downstream of the intake at

FIGURE III-22



INCLUDING IDENTIFIED TAXA, TOTAL FISH COLLECTED
AND PERCENT OCCURRENCE

	Upstream[1]		Downstream[2]		Burnt Cane Creek[3]	
TAXA	No.	%	No.	%	No.	%
Clupeidae	725	89.8	610	88.2	231	90.9
Cyprinidae	25	3.1	16	2.3	7	2.8
Catostomidae	17	2.1	7	1.0	1	0.4
Centrarchidae	24	3.0	32	4.6	12	4.7
Percichthyidae	9	1.1	8	1.2	1	0.4
Percidae	0	0	0	0	1	0.4
Sciaenidae	0	0	1	0.1	0	0
Unidentified	7	0.9	18	2.6	1	0.4
Total	807	100	692	100	254	100

1. Upstream Sample Station----------WRM 407.3-407.8
2. Downstream Sample Station----------WRM 406.0-406.5
3. Burnt Cane Creek----------WRM 407.1

TABLE III-9

SUMMARY OF 1979 LARVAL FISH DATA
BY SAMPLE STATION INCLUDING IDENTIFIED TAXA,
TOTAL FISH COLLECTED AND PERCENT OCCURRENCE

	Upstream[1]		Downstream[2]		Burnt Cane Creek[3]		Intake Pipe Discha	
Taxa	No.	%	No.	%	No.	%	No.	%
Clupeidae	369	91.4	226	93.8	4	33.3	29	74.
Cyprinidae	1	0.2	1	0.4	0	0	0	
Catostomidae	2	0.5	1	0.4	0	0	1	2.
Centrarchidae	26	6.4	11	4.6	8	66.7	8	20.
Polyoden. Spathula	0	0	1	0.4	0	0	0	
Percidae	2	0.5	0	0	0	0	0	
Sciaenidae	0	0	0	0	0	0	0	
Unidentified	4	1.0	1	0.4	0	0	1	2.
Total	404	100	241	100	12	100	39	100.

1. Upstream Sample Station----------WRM 407.3-407.8
2. Downstream Sample Station----------WRM 406.0-406.5
3. Burnt Cane Creek----------WRM 407.1
4. Intake Pipe Discharge----------Discharge Point at Storage Pond

the downstream sample station. The total number of larvae identified from each sample station and sample depth, as well as water temperatures recorded during each sample period, are presented in Appendix B tables.

The effects of entrainment mortality on larval fish populations in the Warrior River is considered insignificant, based on larval fish data collected during the two year study. The effects of intake operation on larval fish populations is further considered insignificant when water withdrawal rates associated with Unit No. 1 operation are analyzed. Table III-10 shows total daily water withdrawal rates and Warrior River flow rates for each of the 1979 larval fish sample dates. The percent of river flow withdrawn by intake operation, as shown in the previously referenced table, is considered negligible relative to impacts on larval fish populations existing in the river. The maximum rate of river flow withdrawn by intake pumps during the study was 2.8%, while the average rate of withdrawal for the 1979 spawning period was only 1.2%.

Daily Plant Intake Pump Flows,
Warrior River Flows and Percent of River Flow
Withdrawn by Intake Pumps
During Each Larval Fish Sample Period
1979

Sample Date	Intake Water (Flow (MGD)	Warrior River Flow (MGD)	Percent of River Flow Withdrawn
3/9/79	6.75	8,164.9	0.08
3/21/79	0	4,219.2	-
4/5/79	10.80	8,389.2	0.13
4/19/79	0	8,167.5	-
5/1/79	20.70	4,752.4	0.44
5/15/79	17.55	1,372.8	1.28
5/31/79	6.30	1,511.1	0.42
6/13/79	19.80	1,515.0	1.31
6/27/79	18.45	1,206.0	1.53
7/12/79	15.30	1,606.7	0.95
7/26/79	39.60	1,856.2	2.18
8/7/79	40.50	1,444.5	2.80
8/22/79	18.45	1,018.6	1.81
		Average =	1.18

Monitoring Procedures

An aquatic macroinvertebrate sampling program was initiated on the Mulberry Fork of the Black Warrior River in August, 1977. Aquatic macroinvertebrate populations were assessed for possible entrainments effects resulting from intake operation, using Hester-Dendy multiple-plate samplers. Samples were collected on a quarterly basis from both the east and west banks of the river at two sample stations. Sample stations included: (1) an upstream station located approximately 0.5 miles above the plant intake, and (2) a downstream sample station located approximately 0.6 miles below the plant intake.

Results and Discussion

Macroinvertebrate population studies were begun in August, 1977 and extended through November, 1979. A total of 40 macroinvertebrate taxa were identified from the multiple-plate samplers collected during the study. Table III-11 is a list of the macroinvertebrate taxa recorded during the study, as well as the sample areas from which they were collected.

Macroinvertebrate population densities varied considerably during the study. The number of organisms represented by each taxonomic group, for each sample area and sample period, are presented in Tables III-12 through III-14. A summary of macroinvertebrate population densities is presented in Table III-15. The previously referenced table shows densities for the east and west bank sample stations, as well as an average density value for each sample station, during the ten sample periods. Average macroinvertebrate population densities were similar in the two sample areas during all but one sample period. Data collected during the fourth quarter of 1978 indicated higher population densities in the downstream sample station than the upstream

	Sample Areas	
	Upstream[1]	Downstream[2]
Alloceoela		
Dugesia	X	X
Coelenterata		
Hydra	X	X
Coleoptera		
Bidessus	X	
Hydroporus		X
Crustecea		
Asellus	X	X
Gammarus	X	X
Hyalella	X	X
Cladocera	X	X
Copepoda	X	X
Ostracoda	X	
Diptera		
Byrilla		X
Chironomus	X	X
Cricotopus	X	X
Goeldichironomus	X	
Orthocladius	X	
Metriocnemus	X	X
Polypedilum	X	X
Psectrocladius	X	X
Tanytarsus	X	X
Trichocladius		X
Pentaneurini	X	X
Simuliidae	X	X
Tipulidae	X	
Ephemeroptera		
Bactis		X
Caenis	X	X
Ephemerella		X
Isonychia	X	X
Leptophlebia		X
Stenonema	X	X
Hirudinea	X	X
Nematoda	X	X
Odonata		
Argia	X	X
Oligochaeta	X	X
Pelecypoda		
Pisidium	X	X
Plecoptera		
Isoperla	X	X
Trichoptera		
Hydropsyche		X
Orthotrichia		X
Oxyethira	X	X
Polycentropus	X	X
Hydroptilidae	X	X

1. Upstream Sample Station.....WRM 407.3 - 407.8
2. Downstream Sample Station.....WRM 406.0 - 406.5

MACROINVERTEBRATES IDENTIFIED FROM MULTIPLE-PLATE SAMPLERS
AT MILLER STEAM PLANT

1977

NUMBER PER SQUARE FOOT OF SAMPLER

	08/24/77-09/16/77				11/10/77-12/08/77			
	1		2		1		2	
MACROINVERTEBRATES	E	W	E	W	E	W	E	W
COLEOPTERA								
EIDESSUS	0.2	-	-	-	-	-	-	-
HYDROPORUS	-	-	-	-	-	-	-	0.3
CRUSTACEA								
HYALELLA	-	-	-	-	0.3	1.0	1.0	9.7
CLADOCERA	3.0	3.8	2.4	-	-	-	-	-
COPEPODA	-	0.6	-	3.0	2.3	1.7	4.3	-
DIPTERA								
CHIRONOMUS	25.4	30.6	32.2	9.4	9.0	7.3	1.7	8.0
CRICOTOPUS	-	-	-	-	0.7	-	-	0.7
GOELDICHIRONOMUS	-	-	-	-	0.7	-	-	-
METRIOCNEMUS	-	-	-	-	0.7	-	2.0	0.3
POLYPEDILUM	-	0.2	-	-	3.0	0.3	-	1.7
PSECTROCLADIUS	-	-	0.2	-	25.3	15.3	29.0	12.7
TRICHOCLADIUS	-	-	-	-	-	-	-	0.7
PENTANEURINI	7.4	5.8	8.2	6.0	2.7	5.7	2.3	3.7
EPHEMEROPTERA								
BAETIS	-	-	-	0.2	-	-	-	-
ISONYCHIA	-	-	-	-	-	-	0.3	-
STENONEMA	-	-	-	0.2	-	-	-	-
NEMATODA	-	-	-	-	2.3	1.3	2.3	-
ODONATA								
ARCIA	0.6	-	-	0.2	-	-	-	-
OLIGOCHAETA	-	-	-	-	-	-	-	4.3
PLECOPTERA								
ISOPERLA	-	-	-	-	-	-	-	0.7
PELECYPODA								
PISIDIUM	-	0.4	0.2	0.4	-	-	-	-
TRICHOPTERA								
HYDROPSYCHE	-	-	-	-	-	-	-	1.3
POLYCENTROPUS	29.2	28.4	36.0	23.4	-	0.3	0.3	0.3
AVERAGE NO. OF ORGANISMS PER SQUARE FOOT OF SAMPLE	65.8	69.8	79.2	42.8	47.0	33.0	43.3	44.3
TOTAL GENERA	6	7	6	8	10	8	9	13

UPSTREAM ----------WRM 407.3 - 407.8
DOWNSTREAM ------- WRM 406.0 - 406.5

TABLE III-13

MACROINVERTEBRATES IDENTIFIED FROM MULTIPLE-PLATE SAMPLERS
AT MILLER STEAM PLANT

1978

NUMBER PER SQUARE FOOT OF SAMPLER

	02/07/78-03/08/78				05/05/78-06/01/78				08/08/78-09/06/78				11/08/78-12/04/78			
	1		2		1		2		1		2		1		2	
MACROINVERTEBRATES	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W
ALLOEOCOELA																
DUGESIA	-	-	-	-	-	-	-	-	-	-	-	-	0.5	1.0	5.3	0.3
COELENTERATA																
HYDRA	-	-	-	-	-	-	-	-	-	-	-	-	-	4.0	40.0	187.0
CRUSTACEA																
ASELLUS	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-
GAMMARUS	5.0	0.3	-	0.7	0.7	1.0	0.7	7.7	-	-	-	-	-	0.5	1.3	1.0
HYALELLA	-	-	-	-	0.3	-	-	-	-	-	-	-	1.0	-	-	-
COPEPODA	-	-	-	-	3.7	4.7	11.0	0.3	57.3	107.7	60.7	31.0	50.0	46.5	55.3	314.3
DIPTERA																
CHIRONOMUS	-	0.3	-	-	19.0	13.0	8.3	11.0	31.0	26.0	23.7	41.0	16.5	5.5	23.3	14.3
CRICOTOPUS	2.3	1.3	2.3	2.7	1.7	8.0	8.7	2.0	-	1.3	-	-	-	-	-	0.3
ORTHOCLADIUS	-	-	-	-	-	1.0	-	-	-	-	-	-	-	-	-	-
POLYPEDILUM	-	-	-	-	1.3	2.0	3.7	2.0	-	1.3	-	1.3	-	-	-	-
PSECTROCLADIUS	-	-	-	0.3	-	-	2.7	2.0	1.3	4.7	1.3	0.3	4.0	0.5	-	0.3
TANYTARSUS	-	-	-	-	-	-	-	-	1.3	0.3	-	-	-	-	0.3	-
PENTANEURINI	-	-	-	-	9.3	6.7	4.3	8.3	1.0	12.7	1.0	2.0	2.0	0.5	5.0	0.3
SIMULIIDAE	-	-	-	-	0.7	-	-	1.0	-	-	1.3	0.3	-	0.5	-	-
EPHEMEROPTERA																
CAENIS	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-
EPHEMERELLA	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-
ISONYCHIA	-	-	-	-	0.3	0.3	-	-	-	0.3	-	-	-	-	-	-
STENONEMA	-	-	-	-	-	-	-	0.7	-	-	-	-	-	-	-	-
HIRUDINEA	-	-	-	-	1.3	-	-	0.3	-	6.3	5.0	3.7	1.0	-	-	-
ODONATA																
ARGIA	-	-	-	-	0.7	1.3	0.7	1.0	-	0.3	0.3	1.0	0.5	-	-	0.3
OLIGOCHAETA	-	0.7	-	0.3	1.3	19.3	6.3	19.3	9.7	22.0	7.0	12.3	9.0	1.0	4.7	-
PELECYPODA																
PISIDIUM	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-
TRICHOPTERA																
ORTHOTRICHIA	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-
OXYETHIRA	-	-	-	-	-	-	-	-	-	1.3	-	-	-	-	-	-
POLYCENTROPUS	-	-	-	-	-	0.3	0.3	-	1.3	-	0.7	2.7	0.5	-	1.3	1.3
AVERAGE NO. OF ORGANISMS PER SQUARE FOOT OF SAMPLE	7.3	2.7	2.3	4.3	40.3	57.7	47.3	56.0	103.0	184.3	101.0	95.7	85.5	60.0	136.7	519.7
TOTAL GENERA	2	4	1	5	12	11	12	13	7	12	9	10	11	9	9	10

UPSTREAM ---------WRM 407.3-407.8
DOWNSTREAM ~~~~~~~WRM 406.0-406.5

TABLE III-14

MACROINVERTEBRATES IDENTIFIED FROM MULTIPLE-PLATE SAMPLERS
AT MILLER STEAM PLANT

1979

NUMBER PER SQUARE FOOT OF SAMPLER

	01/25/79-02/22/79				05/08/79-06/08/79				08/09/79-09/05/79				10/30/79-11/26/79			
	1		2		1		2		1		2		1		2	
MACROINVERTEBRATES	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W
ALLOEOCOELA																
DUGESIA	-	-	-	-	-	-	-	-	-	-	-	-	0.7	0.3	2.0	-
COELENTERATA																
HYDRA	-	1.7	1.0	0.7	32.7	39.5	30.0	78.3	-	-	-	0.3	22.7	8.7	18.0	22.0
CRUSTACEA																
ASELLUS	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CAMMARUS	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-	1.3
HYALELLA	0.7	-	0.3	0.3	0.3	0.3	-	-	-	-	-	-	-	-	-	-
COPEPODA	3.0	0.3	-	1.0	-	16.0	9.0	5.3	1.7	36.3	1.7	7.7	6.0	5.0	4.5	-
OSTRACODA	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DIPTERA																
BRILLA	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-
CHIRONOMUS	2.0	2.0	-	1.0	2.3	5.5	1.0	1.3	7.7	10.7	10.7	12.7	1.3	1.0	0.5	-
CRICOTOPUS	1.3	9.3	12.0	16.7	-	1.0	-	-	-	-	0.3	-	0.7	0.7	0.5	2.3
POLYPEDILUM	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-
PSECTROCLADIUS	-	-	-	1.0	0.3	-	0.3	0.7	-	-	-	-	-	-	-	-
PENTANEURINI	-	-	-	-	2.0	1.5	1.0	1.0	-	0.3	-	-	0.3	-	0.5	-
SIMULIIDAE	-	-	-	-	-	2.5	0.3	-	0.3	-	0.7	-	-	0.3	0.5	-
TIPULIDAE	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-
EPHEMEROPTERA																
CAENIS	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-
ISONYCHIA	-	-	-	1.3	-	-	-	0.3	-	-	-	-	-	-	-	-
LEPTOPHLEBIA	-	-	-	0.7	-	-	-	-	-	-	-	-	-	-	-	-
STENONEMA	-	-	-	-	-	1.5	0.3	-	-	-	-	-	-	-	-	-
HIRUDINEA	-	-	-	0.7	1.0	3.0	-	-	6.0	7.3	2.0	1.7	-	-	-	-
NEMATODA	1.0	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-
ODONATA																
ARGIA	0.3	-	-	-	2.0	-	0.7	0.3	-	-	-	-	-	-	-	-
OLIGOCHAETA	-	0.3	0.7	1.7	1.0	-	2.0	1.0	3.3	0.7	-	-	-	-	-	-
PLECOPTERA																
ISOPERLA	0.7	0.7	-	0.3	-	-	-	-	-	-	-	-	0.3	-	-	-
TRICHOPTERA																
POLYCENTROPUS	-	-	-	-	0.7	-	1.0	1.7	1.3	0.7	1.3	2.0	-	0.3	-	-
HYDROPTILIDAE	-	-	-	-	-	-	-	-	-	-	0.3	-	-	0.3	0.5	-
AVERAGE NO. OF ORGANISMS PER SQUARE FOOT OF SAMPLE	9.7	14.3	14.0	25.7	42.3	71.3	45.7	90.3	20.3	56.3	17.3	24.3	32.3	16.7	27.0	25.7
TOTAL GENERA	9	6	4	12	9	10	10	10	6	7	8	5	8	8	8	3

UPSTREAM ----------WRM 407.3-407.8
DOWNSTREAM----------WRM 406.0-406.5

TABLE III-15

AVERAGE MACROINVERTEBRATE DENSITIES DETERMINED FROM MULTIPLE-PLATE SAMPLERS COLLECTED FROM THE BLACK WARRIOR RIVER NEAR THE J. H. MILLER STEAM PLANT 1977 - 1979

SAMPLE PERIOD	Upstream[1] East	Upstream[1] West	Upstream[1] E+W Avg. (2)	Downstream[2] East	Downstream[2] West	Downstream[2] E+W Avg. (2)
8/24 - 9/16/77	65.8	69.8	67.8	79.2	42.8	61.0
11/10 - 12/8/77	47.0	33.0	40.0	43.3	44.3	43.8
Average 1977	56.4	51.4	53.9	61.3	43.6	52.4
2/7 - 3/8/78	7.3	2.7	5.0	2.3	4.3	3.3
5/5 - 6/1/78	40.3	57.7	49.0	47.3	56.0	51.7
8/8 - 9/6/78	103.0	184.3	143.7	101.0	95.7	98.4
11/8 - 12/4/78	85.5	60.0	72.8	136.7	519.7	328.2
Average 1978	59.0	76.2	67.6	71.8	168.9	120.4
1/25 - 2/22/79	9.7	14.3	12.0	14.0	25.7	19.9
5/8 - 6/8/79	42.3	71.3	56.8	45.7	90.3	68.0
8/9 - 9/5/79	20.3	56.3	38.3	17.3	24.3	20.8
10/30 - 11/26/79	32.3	16.7	24.5	27.0	25.7	26.4
Average 1979	26.2	39.7	32.9	26.0	41.5	33.8

1. Upstream Sample Station----------WRM 407.3-407.8
2. Downstream Sample Station----------WRM 406.0-406.5

sample station. A review of the data (see Table III-13) indicates that the unusually high density of organisms in the downstream station was the result of large numbers of Hydra and Copepoda. With the exception of the previously mentioned groups, the upstream and downstream areas were similar in population composition. Average macroinvertebrate densities occuring in each of the sample areas during each sample period are presented in Figure III-23.

Diversity and equitability values (Weber, 1973)[1] were calculated for macroinvertebrate populations based on data collected from multiple-plate samplers. The diversity and equitability calculations for macroinvertebrate populations are presented for each sample area and sample period in Table III-16. Diversity values for both sample areas were consistently above 2.0 during the study period, and equitability values were above 0.5 during all but two sample periods in both the upstream and downstream sample areas. Diversity values less than 1.0 and equitability values less than 0.5 have been said to be indicative of some type of environmental stress (ibid., Weber, 1973).

A graphical presentation of average diversity and equitability values is presented in Figures III-24 and III-25. A decline in macroinvertebrate population parameters, as shown in the previously referenced Figures, indicates population changes were taking place during the study. Changes in macroinvertebrate populations were not, however, restricted to one sample area but appeared to be similar throughout the study area. A statistical analysis

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1. Weber, Cornelius I. 1973. Biological Field and Laboratory Methods. U.S. E.P.A., Cincinnati. E.P.A. - 670/4-73-001.

FIGURE III-23

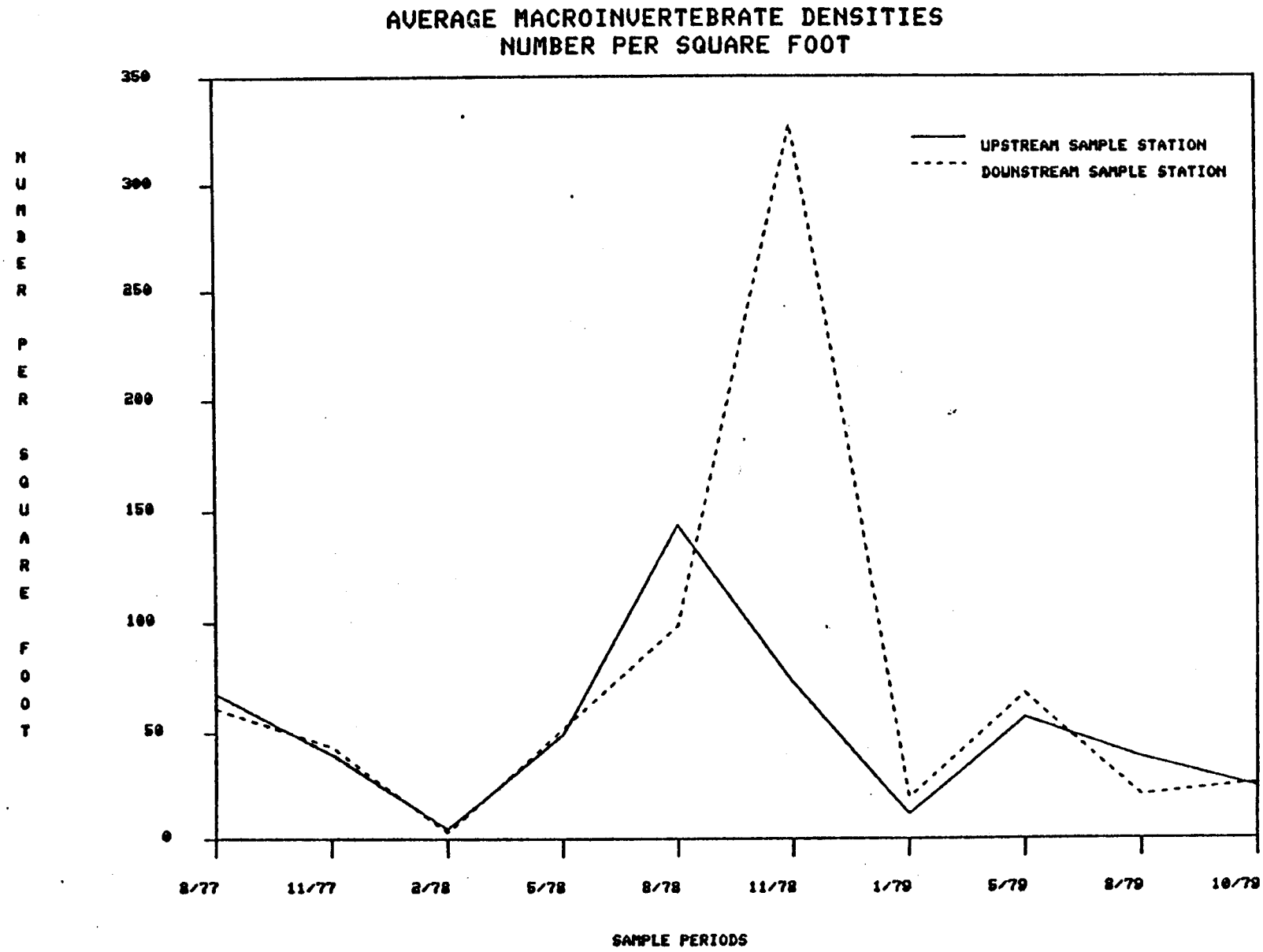


TABLE III-16

AVERAGE MACROINVERTEBRATE DIVERSITY
AND EQUITABILITY VALUES FOR EACH SAMPLE STATION BY SAMPLE DATE
1977 - 1979

LOCATION	DATE	AVERAGE DIVERSITY EAST & WEST BANKS COMBINED	AVERAGE EQUITABILITY EAST & WEST BANKS COMBINED
Upstream (1)	Aug.-Sept. '77	1.46	0.70
Downstream(2)	Aug.-Sept. '77	1.49	0.59
Upstream	Nov.-Dec. '77	1.86	0.65
Downstream	Nov.-Dec. '77	1.99	0.74
Upstream	Feb.-Mar. '78	0.69	1.00
Downstream	Feb.-Mar. '78	0.64	0.75
Upstream	May-June '78	2.18	0.67
Downstream	May-June '78	2.56	0.82
Upstream	Aug.-Sept. '78	1.93	0.57
Downstream	Aug.-Sept. '78	1.81	0.54
Upstream	Nov.-Dec. '78	2.01	0.77
Downstream	Nov.-Dec. '78	1.21	0.48
Upstream	Jan.-Feb. '79	1.80	1.00
Downstream	Jan.-Feb. '79	1.25	0.59
Upstream	May-June '79	1.45	0.44
Downstream	May-June '79	0.90	0.28
Upstream	Aug.-Sept. '79	1.71	0.84
Downstream	Aug.-Sept. '79	1.36	0.66
Upstream	Oct.-Nov. '79	1.13	0.38
Downstream	Oct.-Nov. '79	0.82	0.72

(1) Upstream Sample Station----------WRM 407.3-407.8
(2) Downstream Sample Station----------WRM 406.0-406.5

FIGURE III-24

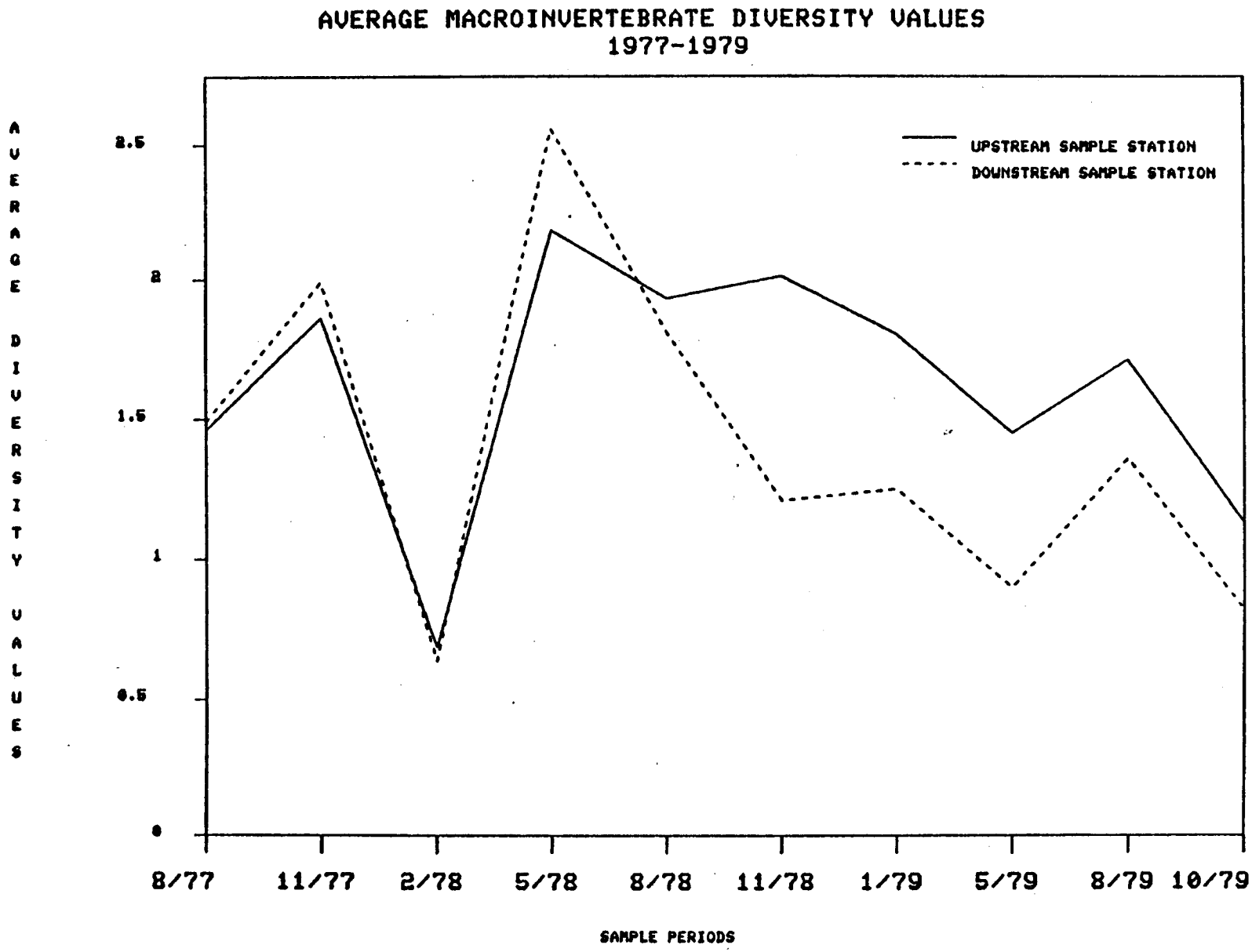
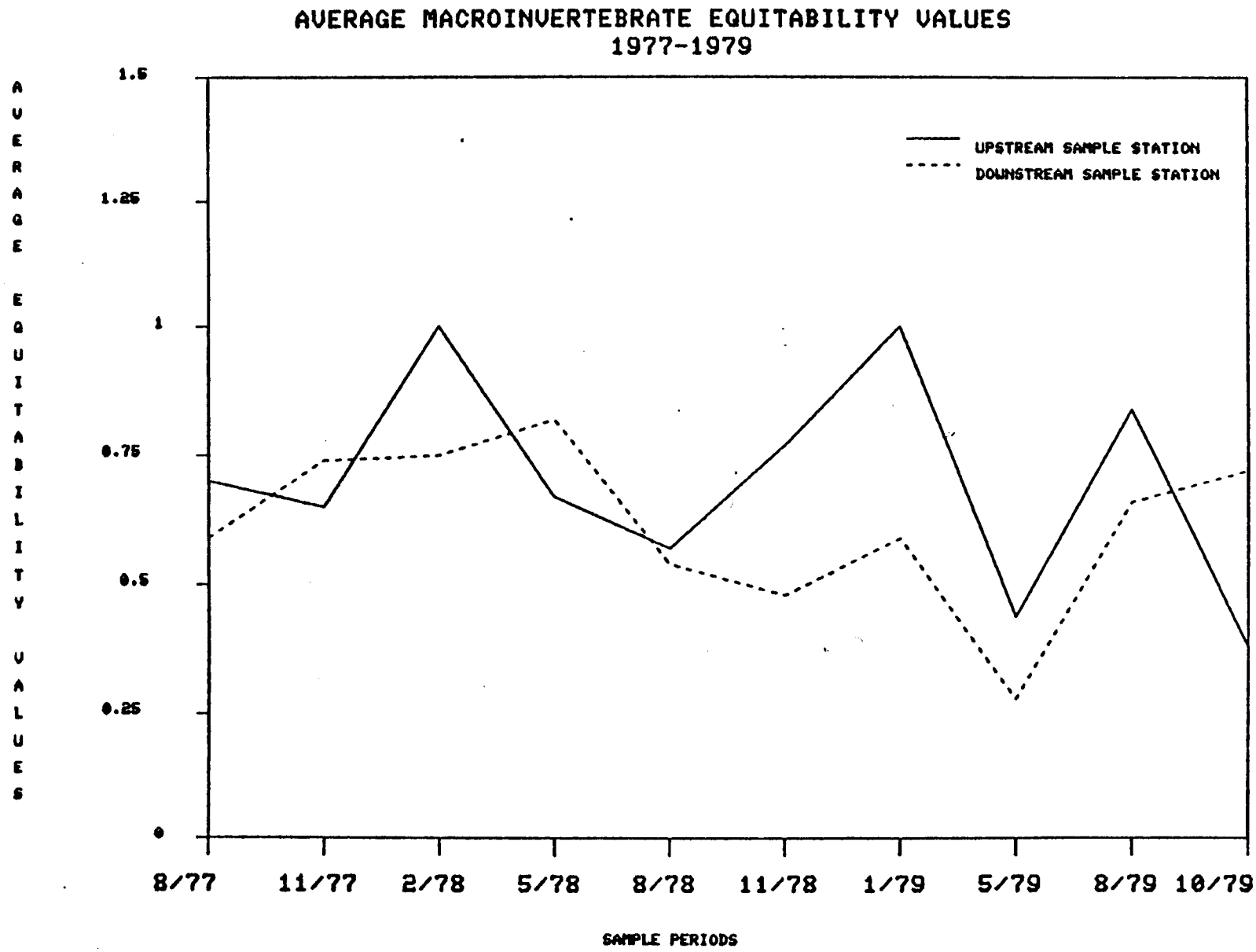


FIGURE III-25



utilizing the Student's "T" statistic for paired samples was used to compare population equitability values among the two sample stations. The results of the previously mentioned analysis failed to indicate any significant differences, at a confidence limit of 95%, between equitability values computed from data obtained in the upstream sample area and values computed for the downstream sample area. It is concluded that changes in macroinvertebrate populations were similar in both sample areas, and thus no effects could be associated with the operation of the power plant intake. Changes in macroinvertebrate communities were common among both sample stations and are therefore considered the result of normal population fluctuations.

Entrainment Summary and Conclusions

Variations in phytoplankton and zooplankton densities occurred over the course of the study; however, there were no qualitative or quantitative changes in plankton communities of the adjacent Black Warrior River (Mulberry Fork) attributable to entrainment effects of the Miller Steam Plant's Unit No. 1.

Larval fish densities varied among sample areas and sample dates during the 1978 and 1979 monitoring periods. Larval fish taxa and densities upstream of the plant intake, as compared to taxa and densities observed in the downstream sample area, did not indicate the occurrence of significant entrainment effects on these organisms. High river flows which normally occur during the Spring spawning period and low rates of water withdrawal further reduce the possibility of entrainment effects on larval fish.

The assessment of macroinvertebrate populations in the vicinity of the plant intake failed to indicate the presence of any deleterious effects on populations of these organisms, which could be associated with Unit No. 1 operation. Changes in macroinvertebrate populations during the two-year study were determined to be the result of normal population fluctuations and not an effect of plant operation.

1978

Date	Location	Depth(ft)	Fish Taxa	No. Collected	Total No./m^3
3/8/78	Upstream[1]	5'	-	0	0
"	Upstream	10'	-	0	0
"	Upstream	15'	-	0	0
"	Downstream[2]	5'	-	0	0
"	Downstream	10'	-	0	0
"	Downstream	15'	-	0	0
"	Burnt Cane Creek[3]	5'	-	0	0
3/23/78	Upstream	5'	-	0	0
"	Upstream	10'	-	0	0
"	Upstream	15'	-	0	0
"	Downstream	5'	-	0	0
"	Downstream	10'	-	0	0
"	Downstream	15'	-	0	0
"	Burnt Cane Creek	5'	-	0	0
4/5/78	Upstream	5'	Clupeidae	63	0.362
"	Upstream	10'	Clupeidae	1	0.019
"	Upstream	15'	Clupeidae	1	0.006
"	Downstream	5'	Clupeidae	26	0.131
"	Downstream	10'	Clupeidae	13	0.065
"	Downstream	15'	Clupeidae	2	0.013
"	Burnt Cane Creek	5'	Clupeidae	2	0.026
4/20/78	Upstream	5'	Clupeidae	343	
			Cyprinidae	4	
			Centrarchidae	3	
			Unidentified	3	1.432
4/20/78	Upstream	10'	Clupeidae	122	
			Cyprinidae	8	
			Centrarchidae	1	
			Unidentified	3	0.550
4/20/78	Upstream	15'	Clupeidae	90	
			Cyprinidae	13	
			Percichtyidae	3	
			Unidentified	1	0.426
4/20/78	Downstream	5'	Clupeidae	155	
			Centrarchidae	3	
			Percichthyidae	4	
			Unidentified	1	0.628
4/20/78	Downstream	10'	Clupeidae	59	
			Cyprinidae	10	
			Centrarchidae	2	
			Unidentified	4	0.339

1978

Date	Location	Depth(ft)	Fish Taxa	No. Collected	Total No./m^3
4/20/78	Downstream	15'	Clupeidae	171	
			Cyprinidae	5	
			Centrarchidae	1	
			Percichthyidae	3	0.675
4/20/78	Burnt Cane Creek	5'	Clupeidae	206	
			Cyprinidae	5	
			Centrarchidae	2	2.564
5/5/78	Upstream	5'	Clupeidae	12	
			Centrarchidae	1	0.056
	Upstream	10'	Clupeidae	4	0.017
	Upstream	15'	Clupeidae	18	0.065
5/5/78	Downstream	5'	Clupeidae	45	
			Centrarchidae	4	0.243
	Downstream	10'	Clupeidae	9	
			Centrarchidae	1	
			Catostomidae	1	0.054
	Downstream	15'	Clupeidae	6	0.027
	Burnt Cane Creek	5'	Clupeidae	3	
			Cyprinidae	1	
			Percidae	1	
			Unidentified	1	0.081
5/17/78	Upstream	5'	-	0	0
	Upstream	10'	Clupeidae	1	0.005
	Upstream	15'	Clupeidae	3	0.012
	Downstream	5'	Clupeidae	3	0.012
	Downstream	10'	Clupeidae	1	
			Centrarchidae	1	0.008
	Downstream	15'	-	0	0
	Burnt Cane Creek	5'	Cyprinidae	1	0.014
6/1/78	Upstream	5'	Clupeidae	5	
			Centrarchidae	2	0.043
	Upstream	10'	Clupeidae	16	
			Centrarchidae	10	
			Catostomidae	3	
			Percichthyidae	4	0.181
	Upstream	15'	Clupeidae	1	
			Centrarchidae	1	
			Catostomidae	14	0.089
	Downstream	5'	Clupeidae	42	
			Centrarchidae	6	
			Sciaenidae	1	
			Unidentified	7	0.319
	Downstream	10'	Clupeidae	29	
			Centrarchidae	5	
			Catostomidae	1	
			Unidentified	4	0.202

1978

Date	Location	Depth(ft)	Fish Taxa	No. Collected	Total No./m^3
6/1/78	Downstream	15'	Clupeidae	11	
			Centrarchidae	6	
			Catostomidae	6	
			Unidentified	1	0.109
	Burnt Cane Creek	5'	Clupeidae	9	
			Centrarchidae	6	
			Catostomidae	1	
			Percichthyidae	1	0.213
6/12/78	Upstream	5'	Centrarchidae	2	0.011
	Upstream	10'	Clupeidae	2	0.009
	Upstream	15'	-	0	0
	Downstream	5'	Cyprinidae	1	
			Centrarchidae	1	0.010
	Downstream	10'	-	0	0
		15'	Clupeidae	2	0.010
	Burnt Cane Creek	5'	Centrarchidae	2	0.027
6/28/78	Upstream	5'	Clupeidae	3	
			Centrarchidae	1	0.019
	Upstream	10'	Clupeidae	4	0.016
	Upstream	15'	Clupeidae	1	0.005
	Downstream	5'	Clupeidae	6	
			Centrarchidae	1	0.035
	Downstream	10'	Clupeidae	1	
			Centrarchidae	1	0.009
	Downstream	15'	Clupeidae	2	0.009
	Burnt Cane Creek	5'	Clupeidae	6	
			Centrarchidae	2	0.106
7/11/78	Upstream	5'	Clupeidae	17	
			Centrarchidae	2	
			Percichthyidae	2	0.087
	Upstream	10'	Clupeidae	9	0.041
	Upstream	15'	Clupeidae	3	
			Centrarchidae	1	0.017
	Downstream	5'	Clupeidae	5	0.025
	Downstream	10'	Clupeidae	13	0.054
	Downstream	15'	Clupeidae	5	0.019
	Burnt Cane Creek	5'	Clupeidae	3	0.035

1978

Date	Location	Depth(ft)	Fish Taxa	No. Collected	Total No./m^3
7/26/78	Upstream	5'	Clupeidae	2	0.010
	Upstream	10'	-	0	0
	Upstream	15'	-	0	0
	Downstream	5'	Clupeidae	1	0.004
	Downstream	10'	Clupeidae	3	0.014
	Downstream	15'	-	0	0
	Burnt Cane Creek	5'	Clupeidae	2	0.028
8/8/78	Upstream	5'	Clupeidae	4	0.017
	Upstream	10'	-	0	0
	Upstream	15'	-	0	0
	Downstream	5'	-	0	0
	Downstream	10'	-	0	0
	Downstream	15'	-	0	0
	Burnt Cane Creek	5'	-	0	0
8/21/78	Upstream	5'	-	0	0
	Upstream	10'	-	0	0
	Upstream	15'	-	0	0
	Downstream	5'	Unidentified	1	0.005
	Downstream	10'	-	0	0
	Downstream	15'	-	0	0
	Burnt Cane Creek	5'	-	0	0

1. Upstream Sample Area----------WRM 407.3-407.8
2. Downstream Sample Area----------WRM 406.0-406.5
3. Burnt Cane Creek----------WRM 407.1

1979

Date	Location	Depth(ft)	Fish Taxa	No. Collected	Total No./m^3
3/9/79	Upstream[1]	5'	-	-	0
	Upstream	10'	-	-	0
		15'	-	-	0
	Downstream[2]	5'	-	-	0
		10'	-	-	0
		15'	-	-	0
	Burnt Cane Creek[3]	5'	-	-	0
	Intake Pipe Discharge[4]	-	-	-	No sample collected
3/21/79	Upstream	5'	-	-	0
		10'	-	-	0
		15'	-	-	0
	Downstream	5'	-	-	0
		10'	-	-	0
		15'	-	-	0
	Burnt Cane Creek	5'	-	-	0
	Intake Pipe Discharge	-	-	-	No sample collected
4/5/79	Upstream	5'	Percidae	1	0.005
	Upstream	10'	-	-	0
	Upstream	15'	Centrarchidae	1	0.005
	Downstream	5'	-	-	0
	Downstream	10'	-	-	0
	Downstream	15'	-	-	0
	Burnt Cane Creek	5'	-	-	0
	Intake Pipe Discharge	-	-	-	No sample collected
4/19/79	Upstream	5'	Unidentified	1	0.010
			Clupeidae	1	
	Upstream	10'	-	-	0
	Upstream	15'	Centrarchidae	1	0.005
	Downstream	5'	-	-	0
	Downstream	10'	Clupeidae	1	0.005
	Downstream	15'	-	-	0
	Burnt Cane Creek	5'	-	-	0
	Intake Pipe Discharge	2'	-	-	0

Date	Location	Depth(ft)	Fish Taxa	No. Collected	Total No./m^3
5/1/79	Upstream	5'	Centrarchidae	3	
			Clupeidae	1	0.017
	Upstream	10'	Centrarchidae	1	0.005
	Upstream	15'	Clupeidae	1	
			Centrarchidae	2	
			Percidae	1	
			Catostomidae	1	0.022
	Downstream	5'	Centrarchidae	2	0.009
	Downstream	10'	Centrarchidae	2	
			Polyodon spathula	1	0.014
	Downstream	15'	Centrarchidae	1	0.004
	Burnt Cane Creek Intake Pipe	5'	Clupeidae	2	0.029
	Discharge	5'	Centrarchidae	1	
			Clupeidae	2	0.091
5/15/79	Upstream	5'	Clupeidae	60	
			Unidentified	1	0.241
	Upstream	10'	Clupeidae	29	0.149
	Upstream	15'	Clupeidae	242	
			Unidentified	1	0.915
	Downstream	5'	Clupeidae	58	
			Centrarchidae	1	0.264
	Downstream	10'	Clupeidae	51	
			Unidentified	1	0.241
	Downstream	15'	Clupeidae	72	0.291
	Burnt Cane Creek Intake Pond	5'	-	-	0
	Discharge	2'	-	-	0
			Clupeidae	2	
5/31/79	Upstream	5'	Centrarchidae	11	0.062
	Upstream	10'	Centrarchidae	4	
			Clupeidae	1	0.027
	Upstream	15'	Centrarchidae	1	
			Clupeidae	1	0.011
	Downstream	5'	Centrarchidae	1	
			Clupeidae	3	0.020
	Downstream	10'	Centrarchidae	1	
			Clupeidae	1	0.009
	Downstream	15'	Centrarchidae	1	
			Clupeidae	3	0.019
	Burnt Cane Creek Intake Pipe	5'	Clupeidae	1	0.015
	Discharge	2'	Clupeidae	2	0.034

1979

Date	Location	Depth(ft)	Fish Taxa	No. Collected	Total No./m^3
6/13/79	Upstream	5'	Clupeidae	11	0.054
	Upstream	10'	Clupeidae	7	0.034
	Upstream	15'	Clupeidae	10	0.044
	Downstream	5'	Clupeidae	14	0.065
	Downstream	10'	Clupeidae	3	0.014
	Downstream	15'	Clupeidae	7	
			Catostomidae	1	0.039
	Burnt Cane Creek Intake Pipe	5'	Clupeidae	1	0.014
	Discharge	2'	Clupeidae	3	
			Centrarchidae	2	0.041
6/27/80	Upstream	5'	-	-	0
	Upstream	10'	Clupeidae	1	0.005
	Upstream	15'	Catostomidae	1	0.005
	Downstream	5'	Clupeidae	4	0.018
	Downstream	10'	Clupeidae	1	0.005
	Downstream	15'	Clupeidae	1	
			Centrarchidae	1	0.010
	Burnt Cane Creek Intake Pipe	5'	Centrarchidae	2	0.026
	Discharge	2'	Clupeidae	16	
			Unidentified	1	
			Catostomidae	1	0.100
7/12/79	Upstream	5'	Clupeidae	1	
			Centrarchidae	1	0.009
	Upstream	10'	Centrarchidae	1	0.005
	Upstream	15'	Cyprinidae	1	0.006
	Downstream	5'	Cyprinidae	1	
			Centrarchidae	1	0.012
	Downstream	10'	-	-	0
	Downstream	15'	Clupeidae	1	0.005
	Burnt Cane Creek Intake Pipe	5'	Centrarchidae	5	0.069
	Discharge	2'	Clupeidae	1	
			Centrarchidae	2	0.020
7/26/79	Upstream	5'	Unidentified	1	0.005
	Upstream	10'	-	-	0
	Upstream	15'	Clupeidae	1	0.005
	Downstream	5'	Clupeidae	1	0.005
	Downstream	10'	-	-	0
	Downstream	15'	-	-	0
	Burnt Cane Creek Intake Pipe	5'	-	-	0
	Discharge	2'	Clupeidae	1	
			Centrarchidae	1	0.013

Date	Location	Depth(ft)	Fish Taxa	No. Collected	Total No./m^3
8/7/79	Upstream	5'	Clupeidae	1	0.006
	Upstream	10'	-	-	0
	Upstream	15'	-	-	0
	Downstream	5'	Clupeidae	3	0.013
	Downstream	10'	-	-	0
	Downstream	15'	-	-	0
	Burnt Cane Creek	5'	Centrarchidae	1	0.013
	Intake Pipe Discharge	2'	Clupeidae	3	0.016
8/22/79	Upstream	5'	-	-	0
	Upstream	10'	-	-	0
	Upstream	15'	-	-	0
	Downstream	5'	Clupeidae	2	.009
	Downstream	10'	-	-	0
	Downstream	15'	-	-	0
	Burnt Cane Creek	5'	No sample taken		
	Intake Pipe Discharge	2'	Clupeidae	1	
			Centrarchidae	2	0.015

1. Upstream Sample Area----------WRM 407.3-407.8
2. Downstream Sample Area----------WRM 406.0-406.5
3. Burnt Cane Creek----------WRM 407.1
4. Intake Pipe Discharge----------Discharge Point at Storage Pond

TABLE B-3

TEMPERATURE AND DISSOLVED OXYGEN DATA
FOR LARVAL FISH SAMPLE PERIODS
ON THE BLACK WARRIOR RIVER NEAR THE MILLER STEAM PLANT

1978

Sample Date	Sample Location	Temperature/Dissolved Oxygen Data				
		0.0 ft.	3 ft.	5 ft.	10 ft.	
3/8/78	Upstream[1]	7.0/11.0	6.8/11.0	6.4/11.0	6.3/11.0	6
	Downstream[2]	7.6/10.4	7.0/10.7	6.8/10.5	6.7/10.6	6
	Burnt Cane Creek[3]	8.2/11.8	7.6/11.6	7.2/11.5	6.8/11.5	6
3/23/78	Upstream	13.0/9.7	12.8/9.6	12.0/9.5	11.9/9.4	11
	Downstream	12.2/9.9	12.0/9.8	11.8/9.8	11.5/9.7	11
	Burnt Cane Creek	13.0/9.6	12.0/9.6	11.5/9.7	11.1/9.7	11
4/5/78	Upstream	23.5/10.5	21.5/11.3	20.8/11.4	17.0/11.5	15
	Downstream	23.8/10.4	22.2/11.0	21.5/11.0	18.5/10.8	15
	Burnt Cane Creek	23.6/10.4	21.0/10.4	19.0/9.8	15.3/7.5	14
4/20/78	Upstream	21.1/7.4	21.1/7.4	20.9/7.2	20.2/6.9	18
	Downstream	22.4/7.1	22.3/7.0	22.1/7.0	21.4/6.9	19
	Burnt Cane Creek	21.0/7.4	20.9/7.2	19.2/6.5	18.3/5.3	
5/5/78	Upstream	17.8/7.0	17.2/6.9	17.0/6.8	17.0/6.7	17
	Downstream	17.7/7.1	17.0/7.0	16.9/7.0	16.9/7.0	16
	Burnt Cane Creek	17.3/8.5	15.0/8.6	15.0/8.6	15.0/8.5	15
5/17/78	Upstream	15.0/8.6	14.2/8.7	14.0/8.7	13.8/8.8	13
	Downstream	16.5/8.7	15.2/8.6	15.0/8.5	15.0/8.5	15
	Burnt Cane Creek	19.1/8.0	18.8/8.1	16.5/8.1	15.0/8.1	

TABLE B-3

TEMPERATURE AND DISSOLVED OXYGEN DATA
FOR LARVAL FISH SAMPLE PERIODS
ON THE BLACK WARRIOR RIVER NEAR THE MILLER STEAM PLANT
1978

Sample Date	Sample Location	Temperature/Dissolved Oxygen Data				
		0.0 ft.	3 ft.	5 ft.	10 ft.	
6/1/78	Upstream	25.7/7.2	20.2/6.8	20.0/6.8	19.5/6.6	19
	Downstream	24.6/7.4	20.6/7.1	20.0/6.7	19.4/6.5	19
	Burnt Cane Creek	27.9/8.0	20.7/7.5	19.7/6.2	16.9/4.5	15
6/12/78	Upstream	17.1/8.5	15.3/8.3	15.0/8.2	14.8/8.1	14
	Downstream	17.4/7.8	15.2/8.3	14.8/8.2	14.7/8.2	14
	Burnt Cane Creek	24.8/8.3	19.0/7.6	16.2/7.6	16.2/7.6	
6/28/78	Upstream	21.9/7.7	17.5/7.9	17.3/7.7	17.3/7.6	17
	Downstream	20.5/7.8	18.0/8.0	17.6/8.0	17.3/7.8	17
	Burnt Cane Creek	28.6/7.0	24.2/7.2	20.3/7.3	19.2/6.3	
7/11/78	Upstream	19.2/7.6	16.8/7.7	15.4/7.9	14.6/7.7	14
	Downstream	21.9/7.8	20.0/7.9	17.0/7.8	16.0/7.6	15
	Burnt Cane Creek	26.5/6.4	24.5/6.0	18.0/7.2	16.8/6.9	
7/26/78	Upstream	22.7/8.5	17.8/8.4	16.7/8.2	16.4/7.9	16
	Downstream	28.2/8.7	26.1/8.7	24.6/8.4	22.1/7.9	19
	Burnt Cane Creek	29.6/8.3	27.7/8.2	23.1/7.5	19.3/6.7	
8/8/78	Upstream	22.6/7.9	21.1/7.9	20.5/7.8	19.0/7.4	18
	Downstream	23.1/7.9	22.3/7.9	21.8/7.8	20.7/7.5	19
	Burnt Cane Creek	26.1/7.2	23.6/6.6	21.1/7.3	19.2/6.3	17

TABLE B-3

TEMPERATURE AND DISSOLVED OXYGEN DATA
FOR LARVAL FISH SAMPLE PERIODS
ON THE BLACK WARRIOR RIVER NEAR THE MILLER STEAM PLANT
1978

Sample Date	Sample Location	Temperature/Dissolved Oxygen Data			
		0.0 ft.	3 ft.	5 ft.	10 ft.
8/21/78	Upstream	27.3/7.5	25.7/7.4	25.3/7.2	23.6/6.8
	Downstream	28.0/7.5	26.2/7.2	25.8/6.7	24.0/6.4
	Burnt Cane Creek	28.7/7.4	26.6/7.3	24.4/6.9	19.0/4.1

1. Upstream Sample Area----------WRM 407.3-407.8
2. Downstream Sample Area----------WRM 406.0-406.5
3. Burnt Cane Creek----------WRM 407.1

TABLE B-4

TEMPERATURE AND DISSOLVED OXYGEN DATA
FOR LARVAL FISH SAMPLE PERIODS
ON THE BLACK WARRIOR RIVER NEAR THE MILLER STEAM PLANT
1979

Sample Date	Sample Location	Temperature/Dissolved Oxygen Data				
		0.0 ft.	3 ft.	5 ft.	10 ft.	
5/31/79	Upstream	15.2/7.7	15.0/7.6	14.8/7.5	14.7/7.4	1
	Downstream	17.7/7.3	16.8/7.1	15.1/7.5	15.1/7.5	1
	Burnt Cane Creek	23.0/6.3	20.2/5.8	19.0/5.4	18.5/6.3	
6/13/79	Upstream	21.1/9.5	18.5/10.6	18.0/8.8	18.0/8.3	1
	Downstream	19.0/8.3	17.8/8.3	17.8/7.8	17.8/7.8	1
	Burnt Cane Creek	24.8/7.7	21.5/7.9	18.5/8.0	18.2/6.3	
6/27/79	Upstream	15.8/7.5	15.1/7.5	15.0/7.4	15.0/7.2	1
	Downstream	18.2/8.1	16.8/8.1	15.9/7.6	15.9/7.3	1
	Burnt Cane Creek	23.0/8.1	19.0/8.1	16.8/7.7	15.8/7.3	1
7/12/79	Upstream	18.2/6.3	18.2/6.2	18.0/6.2	18.0/6.2	1
	Downstream	20.0/5.8	18.8/5.6	18.3/5.6	18.1/5.5	1
	Burnt Cane Creek	22.9/6.3	20.5/5.3	19.8/4.3	18.7/5.4	
7/26/79	Upstream	22.0/7.0	20.5/6.5	20.2/6.4	19.9/6.4	1
	Downstream	22.0/6.8	20.9/6.4	20.7/6.4	20.2/6.4	2
	Burnt Cane Creek	24.8/7.8	22.2/5.1	21.0/6.0	20.1/3.3	1
8/7/79	Upstream	21.6/7.1	19.3/7.0	18.8/6.7	18.0/6.3	1
	Downstream	26.0/7.6	23.0/7.5	21.9/7.2	19.2/6.3	1
	Burnt Cane Creek	29.1/7.8	25.1/6.6	22.0/6.6	19.5/3.3	1

TABLE B-4

TEMPERATURE AND DISSOLVED OXYGEN DATA
FOR LARVAL FISH SAMPLE PERIODS
ON THE BLACK WARRIOR RIVER NEAR THE MILLER STEAM PLANT
1979

Sample Date	Sample Location	Temperature/Dissolved Oxygen Data				
		0.0 ft.	3 ft.	5 ft.	10 ft.	
8/23/79	Upstream	21.8/7.8	20.0/7.4	18.0/6.8	17.4/6.6	1
	Downstream	23.0/8.3	22.0/8.1	20.9/7.5	17.7/6.3	1
	Burnt Cane Creek	25.8/7.6	22.3/7.4	20.2/7.2	18.4/5.8	1

1. Upstream Sample Area----------WRM 407.3-407.8
2. Downstream Sample Area----------WRM 406.0-406.5
3. Burnt Cane Creek----------WRM 407.1

TABLE B-4

TEMPERATURE AND DISSOLVED OXYGEN DATA
FOR LARVAL FISH SAMPLE PERIODS
ON THE BLACK WARRIOR RIVER NEAR THE MILLER STEAM PLANT
1979

Sample Date	Sample Location	Temperature/Dissolved Oxygen Data				
		0.0 ft.	3 ft.	5 ft.	10 ft.	
3/9/79	Upstream(1)	8.1/9.5	8.1/9.4	8.1/9.4	8.1/9.4	
	Downstream(2)	9.0/9.2	9.0/9.1	9.0/9.0	9.0/9.0	
	Burnt Cane Creek(3)	11.1/8.9	10.2/8.8	10.0/8.8	10.0/8.8	
3/21/79	Upstream	11.3/9.5	11.2/9.5	11.2/9.5	11.2/9.4	1
	Downstream	11.0/9.6	11.0/9.5	11.0/9.5	11.0/9.5	1
	Burnt Cane Creek	15.1/9.4	15.0/9.3	14.2/9.3	-	
4/5/79	Upstream	12.2/9.1	12.2/9.1	12.2/9.1	12.2/9.1	1
	Downstream	13.3/8.7	13.3/8.7	13.3/8.6	13.3/8.5	1
	Burnt Cane Creek	17.8/8.5	15.9/8.6	15.1/8.5	14.9/8.4	
4/19/79	Upstream	12.1/8.5	12.1/8.5	12.1/8.5	12.1/8.5	1
	Downstream	12.2/8.5	12.2/8.5	12.2/8.4	12.2/8.5	1
	Burnt Cane Creek	18.8/8.2	17.0/8.0	15.3/7.7	13.9/7.8	
5/1/79	Upstream	13.9/8.8	12.6/8.8	12.4/8.8	12.4/8.8	1
	Downstream	13.3/8.9	13.2/8.8	12.8/8.9	12.7/8.8	1
	Burnt Cane Creek	19.8/8.6	16.3/8.1	14.2/8.4	13.9/8.6	
5/15/79	Upstream	20.6/7.2	18.9/7.2	18.8/7.1	18.6/7.2	1
	Downstream	20.6/7.4	18.5/7.2	18.3/7.2	18.3/7.1	1
	Burnt Cane Creek	21.8/7.9	17.5/7.8	17.0/7.7	-	